HEATING AND VENTILATING

APR 2 2 1944

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Chilling Plane Rivets is only one of numerous applications of Industrial Refrigeration covered in the article on page 47.

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HEATING VENTILATING

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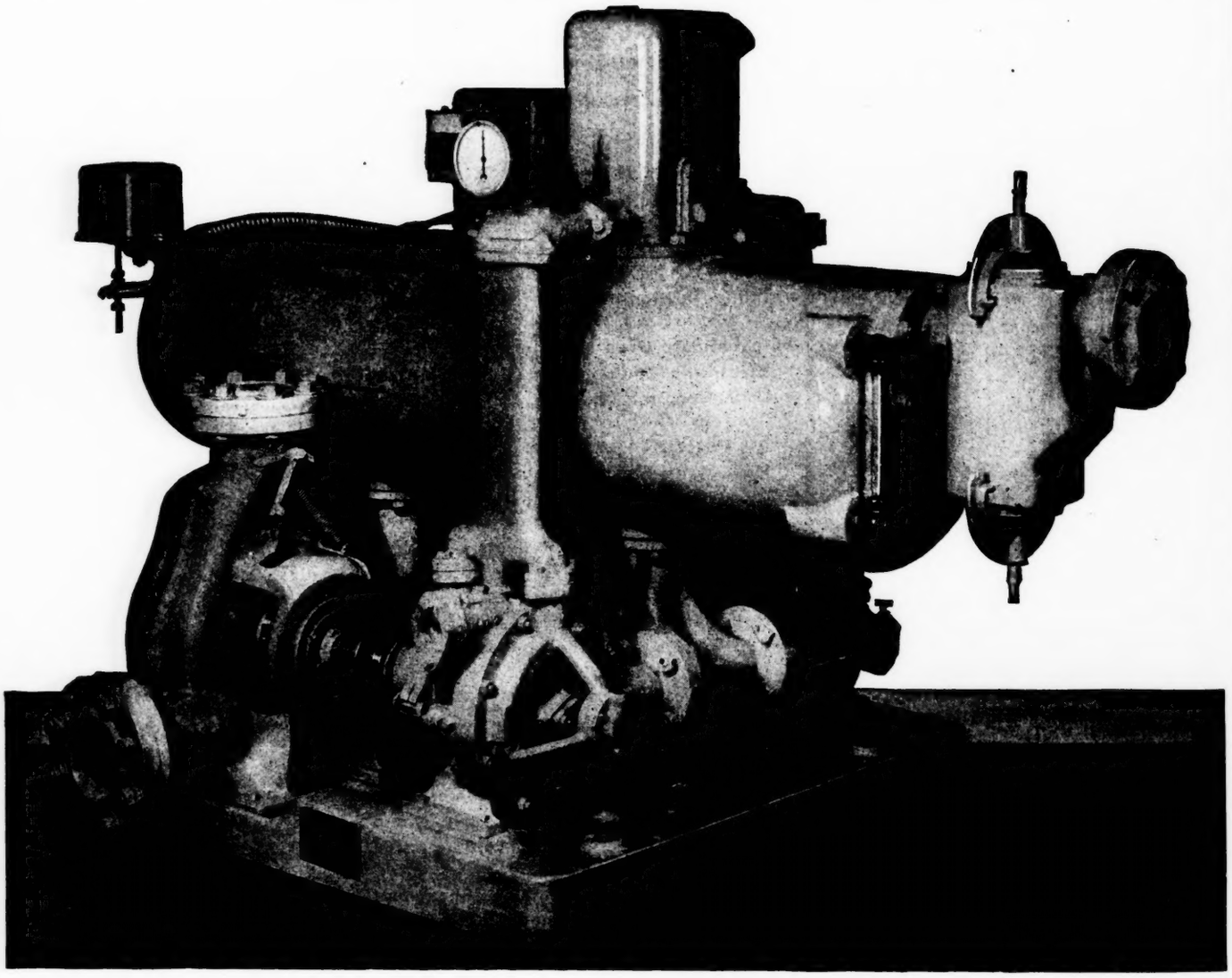
THE COVER

Douglas Aircraft Company Oklahoma City Plant—
Photo Courtesy The Austin Company

Where building heat *MUST NOT FAIL* always specify the Nash Vapor Turbine



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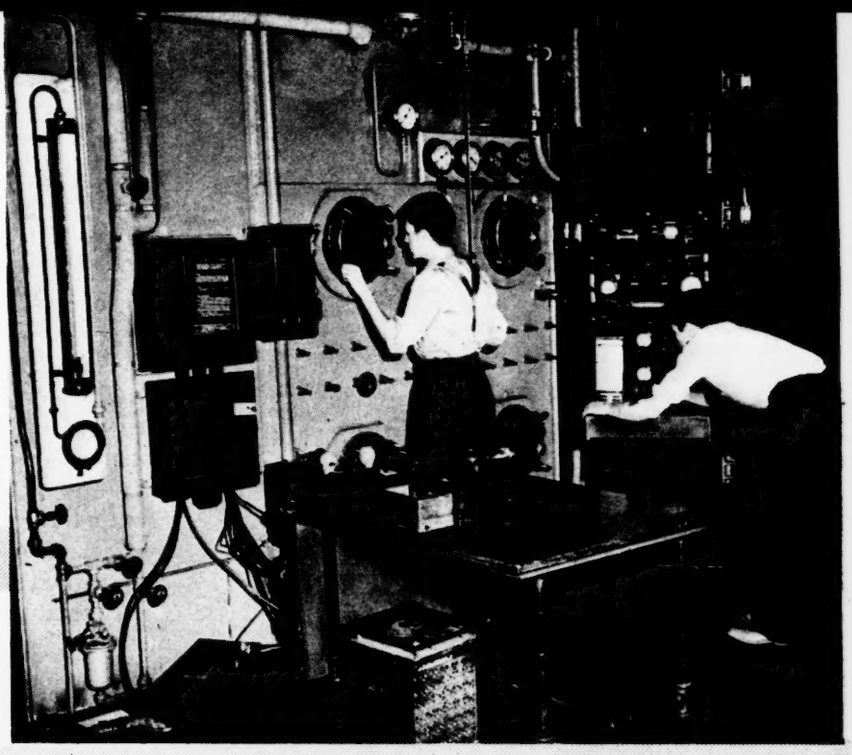


Control panel outside of stratosphere chamber used to test aircraft installations under flight conditions. Both temperature and pressure may be controlled. This cabinet can hold —40F temperature.

Industrial Cooling as a Production Aid

J. PARTINGTON, JR.
Industrial, Contractor and Marine Sales Division, General Electric Co.

WHEN the first Lend-Lease orders stirred industry in this country, industrial cooling was called upon to assist in the battle of production. What is new about industrial cooling is the variety of uses to which it has been put in aiding the war effort.

Industrial cooling equipment has participated largely in the evolutionary changes in industrial techniques which have taken place as a direct result of a world conflict. It is significant to note that in Germany the manufacture of cooling equipment was relegated, according to reports, to a minor place in Schickelgruber's plans for world conquest. Fortunately, such was not the case in the United States.

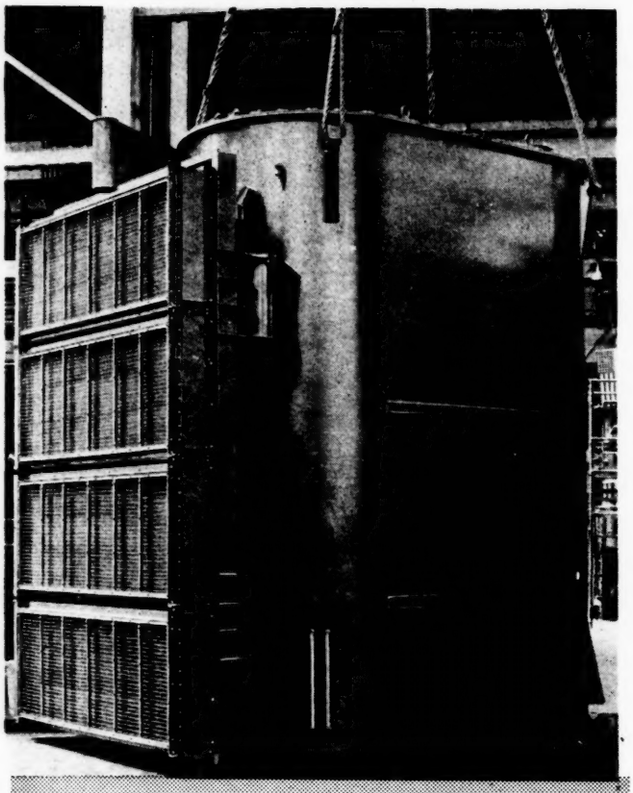
Industrial techniques developed during this war will not be discarded in the post-war era. On the contrary, we have every reason to expect the techniques to achieve increasing recognition and wider acceptance. Thus will be created an ever expanding market for industrial cooling equipment.

Because of the role this market will play in the reconversion period, it is particularly appropriate to devote a few minutes to a resume of some of the newer applications of industrial cooling equipment. All of the story, naturally, cannot be told until the need for wartime secrecy is past.

In quest of these newer applications, let us take an inspection trip through a typical industrial plant making Item X for use by the armed forces. After our credentials have been accepted and we have pinned on our visitors' badges, we commence our tour in the company of our guide and proctor, who will see to it that we see only what we should.

The boiler room or power house, since it is the heart of all of the various services throughout the plant, first deserves our attention. Here we notice an evaporative fluid cooler removing heat from the jacket, intercooler and aftercooler of the air compressors which supply shop air throughout the plant. Here, too, since cold-enough city water is not always available, we find a refrigerated dry-expansion heat exchanger being used to remove moisture from the compressed air itself. Dry air is essential if rust is to be avoided when compressed air is used to blow delicate metal parts free of dirt and filings. Should there be any diesel driven auxiliaries, the diesel jackets would also be cooled by evaporative fluid coolers to reduce the strain on already overtaxed city water mains and to protect the engines themselves from the effects of impurities in the water. Evaporative fluid coolers are a sound investment where water costs exceed a dollar a thousand cubic feet.

Next door to the boiler room is the power substation in which are located the distribution transformers. Here we see the forced air-forced oil cooled transformer, a recent innovation brought about by the wartime shortages of strategic materials. Heat



Forced-air, forced-oil cooling installed on power transformer. Photograph shows cooler and cooling support from tank.

resulting from the step-down in voltage is dissipated by pumping the transformer oil through extended fin type heat transfer surface over which large volumes of air are circulated by propeller fans. This evolutionary step in design and construction saves up to 30% of the material used formerly in a transformer of the same kilowatt rating. Such material savings with their consequent weight reductions have made possible portable substations, capable of supplying the needs of a fair sized town. The substations are mounted on trailer chassis small enough to comply with ICC regulations as to size and weight.

Removing Heat Produced by Rectifiers

In the same substation we also find alternating current being converted to direct current by means of copper oxide or ignitron (mercury arc) rectifiers. We find another use for heat transfer equipment in the removal of heat caused by this conversion of power. Fan cooled dry surface extended fin heat exchangers remove heat from the air circulated over the stacks of copper oxide rectifiers. City water, unless it exceeds 75F, is used as the transfer medium. Should the city water be too warm, refrigerated water takes up the burden of maintaining rectifier capacity at its peak during the summer months. A forced air-forced water heat exchanger, similar to the transformer cooler, dissipates heat to the outdoors from the cooling jackets of the ignitron rectifiers. Temperature control is effected by varying the number of propeller fans in operation.

Entering the manufacturing area proper, we commence our inspection tour at the receiving dock where all raw material enters the plant. Here, the absence of the usual pile of rusty castings outside the receiving door catches our interest. The accelerated aging of castings by low temperature refrigeration has removed the necessity of their long exposure to the weather and at the same time removed the element of chance which existed with the old method. A more uniform casting, requiring less machining and consequently less wasted material, results from the application of heat transfer equipment.

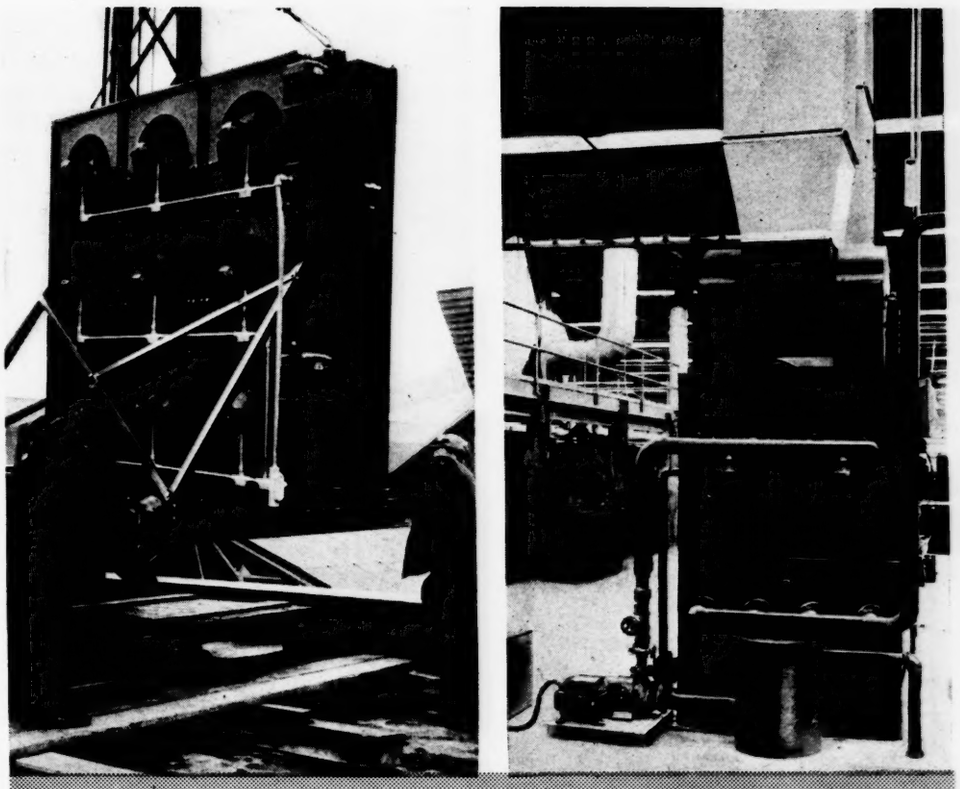
Temperature and humidity control is frequently necessary as soon as the incoming raw material enters the plant. Certain materials, such as the synthetic plastics, must be stored at cool temperatures, while some require dry and others moist atmospheres. These applications can vary in size from small boxes similar to household refrigerators, to entire rooms, depending upon the quantity of material to be stored and the rate of turnover. Industrial cooling equipment is very frequently required to maintain this raw material at its prime.

Cooling in Steel Plants

Starting down the production line, we find the preliminary operations of rolling, forming, forging and shaping being carried on in the conventional manner with certain modern improvements. For example, furnaces used to heat steel billets preparatory to drop forging are now provided with gas converters to furnish controlled inside atmosphere. The absence of oxygen in the furnace atmosphere retards oxidizing while the steel is being heated. Refrigerated gas coolers are frequently necessary to condense moisture from the furnace atmosphere gas, particularly during the summer months when water temperatures are high and water cooling of the gas is inadequate.

Should the furnaces be of the roller hearth variety, another cooling problem presents itself, namely the bearings for rolls over which pass the heated metal parts. With furnace temperatures of 2,500F and heavily insulated fire brick walls, the stored heat in such a furnace is very great and four to six hours are required for the temperature to cool on shut down. Consequently a failure of the cooling water supplying the roller bearings cannot be tolerated. An evaporative fluid cooler with its small water consumption and large storage capacity in the collecting basin presents an ideal solution for the hazard of enforced cooling water failure, as well as offering economical operation. Even after the make-up water line runs dry, the evaporative fluid cooler can continue to function and thereby prevent bearing failure.

The parts leaving the furnace at about 1300F may require rapid quenching in oil or brine to obtain hardness sufficient to withstand severe wear. Since the quench bath temperature must rarely be below 90F, the usual temperatures are 110F to 150F, and refrigeration is not required. However, an evaporative fluid cooler can do the job of heat transfer very economically. For example, 5,000 pounds of steel per hour can be quenched from 1,500F to 100F by using only 5 gpm of make-up water in an evaporative fluid cooler operating in an outdoor wet bulb temperature of 75F. Approximately 75 gallons per minute of 70F city water would be required to handle this application using a shell and tube heat exchanger. A large water saving results.



Left—Installing a unit to cool mercury arc rectifiers. Unit is a fan cooler, dry surface, extended fin heat exchanger. Right, evaporative cooler used for cooling bearings on a roller hearth furnace in a warplant. This same plant is using evaporative coolers, similar to this, for cooling lubricating oil, and jacket water, and intercooler and aftercooler on a 500 hp air compressor.

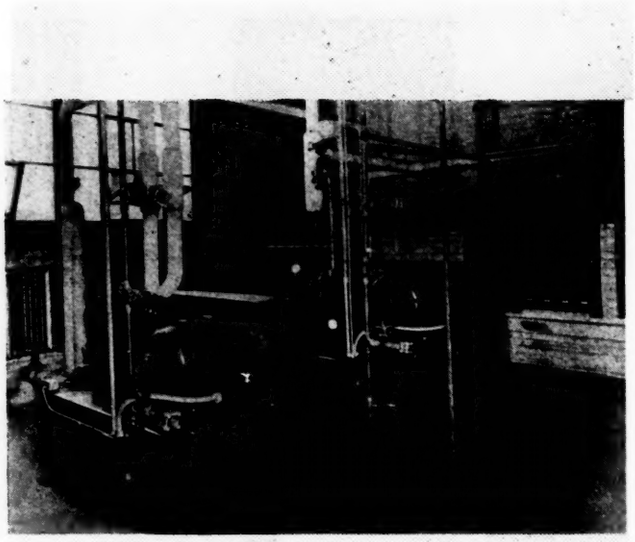
Passing along to the plating department, we find still another use for refrigeration equipment. The fluid in the high speed electro-plating tanks is usually maintained at 70F within narrow limits to obtain best results. Controlled temperature improves the texture and uniformity of the protective zinc, silver or cadmium plating and assures a better product and a more economical use of critical materials. If the parts to be treated are made of aluminum, an anodizing process is used to produce the protective coating. The anodizing process is comparable in many ways to electro-plating. The parts to be processed are immersed in a weak sulfuric or chromic acid solution and electric current is impressed upon both the parts and the bath, the parts becoming one pole and the solution the other. Electricity action liberates oxygen from the bath and deposits it on the aluminum parts in the form of aluminum oxide. Thus a thin film of oxide protects the parent metal and prevents any further oxidation. Immersion in subsequent baths fixes the protective coating so it cannot be wiped off.

The anodizing process requires the dissipation of large amounts of electric current in relatively small tank volumes. In one application, a tank 3 ft by 6 ft by 5 ft deep required an input of 60 kilowatts. This electrical energy is rapidly transformed into heat which tends to raise the bath temperature unreasonably high. However, it has been found that the bath temperature should be maintained at 70F plus or minus one to two degrees for best results, and consequently cooling is necessary. City water, if cool enough, or refrigeration or a combination of the two provides the cooling either by means of lead pipe coils immersed in the tanks or by acid resistant shell and tube heat exchangers through which the anodizing solution is circulated by acid resistant pumps. While today anodizing is reserved for priority applications, in the post-war era it may provide the finish on frying pans and other cooking utensils and thus eliminate the black smudges on millions of dish towels.

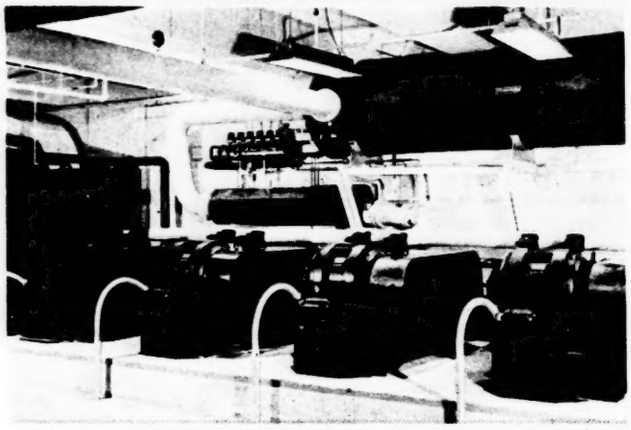
Turning off at the welding booths, we find refrigeration again called into action to keep the electrodes of the spot welders cool.* Refrigerating the electrodes prevents, to a great extent, their sticking to the work and the plastic deformation or mushrooming of the tips due to the intense heat. Production is speeded and operating costs reduced because cooling permits much longer continuous runs before the electrodes must be cleaned and redressed.

As we move along to the machining area, we see portable rivet coolers used to keep aluminum rivets ductile until ready for use. Low temperature mechanical refrigeration is required for this application.

*See "Refrigeration Facilitates Metal Working," by F. O. Jordan, HEATING AND VENTILATING, February, 1944, page 79.



Two of the condensing units used to provide cooling in an air conditioned plant making aircraft devices.



Bank of four 75 hp refrigerating condensing units to provide cooling and office air conditioning in an aircraft plant.

Stopping alongside a high speed precision grinder we observe the stream of whitish fluid coolant pouring over the part being machined to very close tolerances. Refrigeration, by maintaining this coolant at a constant temperature just below room ambient, has made tolerances of two to ten thousandths possible in mass produced parts.

Gear hobbers producing giant herringbone ship propulsion reduction gears also must have refrigerated coolant to prevent variations in gear teeth size. Where extreme accuracy is required, the ambient surrounding the entire hobber and gear must be kept at a constant value within plus or minus one degree during the whole time the work is in process. Cooling of this area by conventional air conditioning is a necessity if production is to be maintained during summer weather.

Coolant coolers are made in portable form in the smaller sizes for application to grinders and other small machine tools. The larger machines such as gear hobbers require permanent installations up to 5 hp in capacity per hobber.

We must not overlook the standards or gauge checking room in our tour, for in this room are kept all the master gauges and fixtures by means of which quality control of production is maintained. Year round temperature is held in these rooms at 70F plus or minus one degree. Relative humidity must be kept at approximately 40% in order to prevent rust formation on the precision instruments. Adequate air filtering is required as well, to keep dust and dirt to a minimum.

Expansion Fitting of Metal Parts

Progressing through the assembly area, we spot another operation which requires refrigeration. This process is known as "expansion fitting", and it is just the reverse of shrink fitting as practiced by the locomotive builders in putting the tires on driving wheels. In expansion fitting the part to be assembled is chilled to a very low temperature, slipped into place, and allowed to expand tightly into its outer member as it warms up to room temperature. The reverse process, requiring the metal to be heated cherry red and later chilled in a water bath, has a tendency to warp or distort many metals. Expansion fitting, on the other hand, prevents alteration of the characteristics of most metals, and in addition to the product is much easier to handle cold than when extremely hot. Temperatures as low as —100F are used in this process so that low temperature mechanical refrigeration equipment is required.

Arriving at the final assembly line, we quite frequently find that air conditioning is required either as an adjunct to air purity or to achieve humidity control. Just the mark of sweaty fingers may cause irreparable damage to certain types of precision instruments in this final stage of manufacture.

Flight Conditions are Duplicated

The final step in the production line occurs in the test and inspection area. Heat transfer equipment in various guises is frequently required. Should the product of the plant be any of the hundreds of items used on airplanes, it will require testing at extremely low temperatures, low vacuum or both. In rare cases, flight similitude conditions will have to be produced to adequately insure correct operation in flight of the parts being tested. The field of stratosphere testing is a large and very complex one offering a challenge to the ingenuity of the best heat transfer experts. No attempt will be made here to go into the problems involved in applying refrigeration equipment to altitude chambers or low temperature cold boxes as they are a field in themselves. Suffice to say that the strides made by the aviation industry would have been virtually impossible in the time allowed were it not for heat transfer equipment brought forward by the demands of industrial evolution.

On our way back to the reception desk where we return our badges, we pass the telephone exchange and see still another application of air conditioning. Cool dust-free air is required to keep the complex maze of relays and contacts that go to make up a dial telephone system, operating efficiently and smoothly. The work of the operators themselves shows a marked improvement over that performed in a room not air conditioned.

Back at the main gate, after our tour of inspection, we cannot help but realize the tremendous job heat transfer equipment is doing in helping win the war. Nor can we help but visualize many uses for cooling equipment in the post-war industrial plant to help us win the peace that is to follow. The few completely air conditioned factories of the present are but forerunners of industrial plants of the future. The industrial evolution that has taken place has merely shown the way toward the ever expanding market which lies ahead.

Investigate Uses of Anthracite Fines

A wider utilization of anthracite "fines" to reduce an annual surplus of 1,000,000 tons of this kind of fuel and to relieve shortages in other fuels is being investigated by Bureau of Mines engineers, Secretary of the Interior Harold L. Ickes has announced.

The investigations and experiments, being made at the request of the office of the Solid Fuels Administration for War, will explore the possibilities of using more anthracite fines—No. 3 size and smaller—to mix with bituminous coal in briquettes, to replace low-volatile coal in by-product coke ovens, and in gas producers that normally use larger sizes of anthracite, the Secretary said.

A program to effect a material reduction in the national stockpile of anthracite fines was begun recently by the Solid Fuels Administration after the Bureau of Mines conducted tests showing that mixtures of anthracite barley and bituminous slack coal will burn in underfeed stoker equipment with about the same efficiency as straight bituminous coal.

Demands for this type of fuel in army camps and private plants are increasing, but additional consumption is necessary under the war program. Anthracite fines are described as a slow-moving fuel, and the piling up of supplies delays the production of larger sizes of anthracite needed for domestic heating purposes.

Outlining the investigations that the bureau will undertake, Dr. R. R. Sayers, director of the bureau, advised Secretary Ickes that engineers will consider whether an increase in the quantity of anthracite used in the briquetting industry is feasible, and whether idle and new-type equipment can be put into operation. A suggestion that some equipment for making building bricks that is not in use at certain seasons can be employed in pressing fuel briquettes also will be investigated.

Experiments will be made with gas producers, Dr. Sayers added, to ascertain whether the installation of a mechanical agitator in the fuel bed will permit the burning of smaller sizes of anthracite than now being used and at the same time maintain the same capacity.

In the coke-oven field, the bureau plans to extend research conducted by private industry in the substitution of anthracite fines for part of the low-volatile bituminous used, since a continuing serious shortage, particularly of central Pennsylvania low-volatile coal, has been predicted.

In one plant last fall, a mixture containing five per cent of anthracite fines was used in place of one with 25% Pocahontas in one-third of its coke production. The coke produced from this 5% anthracite-95% high-volatile coal mixture tested virtually the same and was mixed with regular coke and used in blast furnaces with no ill effects. There was no significant change in the appearance of the coke, the screen analysis, or in the shatter index, and the coking time remained identical. However, there was a decrease in porosity.

Electronic Equipment in Textile Mill Speeds Production

In a southern textile plant, the solution to a vexing problem has been found in the application of electronic devices. At this plant, the application of photoelectric relays to open doors automatically saves time and helps maintain essential temperature and humidity conditions in the weave shed.

It is essential that the doors between the weave shed and the warp sizing room of this plant be closed as soon after opening as possible so as to maintain the much higher humidity and temperature conditions within the weave shed. In the mill's operations, trucks are almost continuously transporting beams of yarn between the two rooms. Then, too, finished rolls of cloth must be brought back through and delivered to the cloth inspection room.

With ordinary doors opened manually, the humidity and temperature conditions were disturbed since the doors would remain open for a considerable length of time. In addition, manual operation meant that it was necessary for the truck operator or someone else to open the doors before the truck could pass through.

G.E. photoelectric relays installed at the approaches to the doors now automatically open the doors as the truck approaches and close them as soon as the truck has passed through.

U. S. Hospital Train

F. N. HOLLINGSWORTH

U. S. Army hospital train built in this country for overseas service. In combat areas, it will have 22 cars.

THERE was recently completed the first overseas type of hospital train to be built in the United States, designed specifically for use in combat areas by the United States Army. The unit consists of ten cars, including six ward cars, two personnel cars for officers and enlisted men, a utilities car, and a kitchen car with one section set off as a pharmacy.

The utilities car contains two oil-fired boiler units for heating the train and for domestic hot water. It has caterpillar diesel generators for lighting and general power purposes.

The cars are only slightly more than half the length of ordinary American railroad cars so they can negotiate the sharp curves, narrow bridges and tunnels of foreign railways. They measure 40 ft long and 8.75 ft wide. Construction of the train, built at the Pullman-Standard Car Company, Worcester, Mass., was supervised by the Transportation Corps of the Army, which operates all Army trains. Plans were drawn by the Corps of Engineers and submitted to the Medical Corps for revision and modification to meet army hospital needs.

Train is Fully Equipped

This train operates as a complete unit within itself, with its own heating, ventilation and refrigeration equipment. The in-line oil burners are electrically operated, but are not used when the train is coupled to a locomotive en route, or when on a siding where steam from railroad equipment can be supplied.

Steam lines are laid out as in a regular passenger train, but with the ward cars zoned so that heat can be manually controlled for each two patients, by means of fin-tube radiators under the lower bunks. Thus a patient in a lower bed who requires considerable heat can have it while ward mates get whatever temperature is required in their particular cases. Those in the upper tier of beds get slightly less heat than those in the lowers, and patients can be classified accordingly. Both upper and lower tiers of beds can be folded back against the sidewalls when not in use.

The car heating steam boilers and the complete system were supplied by the Vapor Car Heating Company, Chicago, with Vapor-Clarkson steam boiler system vapor controls. Heating is controlled to 70F inside against 30F outside.

Ventilation is by a pressure system, with 20 Sturtevant 16-in. blowers in the ceilings, each with a capacity of 1,500 cfm. Intakes are at the side edges of roofs with discharge into cars through circular deflecting grilles. No direct air current hits the patients. Exhaust of about 1,100 cfm is by gravity, through grilles located along the floor. One grille over each berth opens to the outside. There is a special exhaust fan over the sterilizer to eliminate odors.

The refrigeration system of two units is in con-

Type of overhead blower installed in each car to bring in a supply of fresh air.

tinuous operation throughout 24 hours, and is mainly to keep fresh food and medical supplies, and to supply ice cubes for drinking water and ice packs when required. The refrigerator box contains 70 cubic feet and the apparatus has a daily capacity of 1,920 ice cubes, each 1⅜ inches. Car roofs are heavily insulated with a rock felt. In the kitchen car is a dining compartment to accommodate 16 members of the train's operating personnel. Patients are served from trays.

In combat areas this train would ordinarily consist of 22 cars, including 16 ward cars, each of which accommodates 16 bed patients, or slightly more sitting patients. Entrance is either through the ends or side doors. In a rare case, the large center area in each car can be converted into an emergency operating room, in which event a litter is used as an operating table. Normally the wounded would have received first aid and initial treatment before being placed on the train. Personnel of this first train includes four officers, including two doctors, and two medical administrative officers, six nurses, including one chief nurse and 33 enlisted men, all technical specialists trained in medical work, or train operational duties.

The entire train has fluorescent lighting. Small fluorescent lights near the floor illuminate the aisles. Fuel supply is carried in two tanks of 150 gallons each, and a bin holds 1,000 lbs of coal for the kitchen car.

While several hundred of these special cars are being constructed in the United States, an additional number are being built abroad to American Army specifications.

Damaging Effects of Fly Ash on Industrial Equipment and Processes

Certain important facts that justify the use of fly ash precipitators are not always realized, especially so as the great quantity of fly ash released from the stack to the atmosphere is not apparent from ordinary observation. As an example of the quantity of ash involved, assume an installation of two boilers with pulverized coal firing and a total steam generating capacity of 300,000 lb per hour. Such an installation should require a coal consumption of 400 tons per day, so that with a normal ash content of ten per cent, at least 20 tons of fly ash per day should be concentrated within the vicinity of an unprotected stack. This would be on the basis of 50% of the ash released from the stack, a percentage which is fully in accordance with statements as made by recognized authorities on combustion.

Aside from any unfavorable civic action on the objections from neighboring property owners, fly ash quite often is even more objectionable when considered with reference to its effect on plant production and maintenance. Ash particles carried through window ventilators, doorways, and other openings by ordinary drafts or driven by wind contaminate products in the course of manufacture, so that relief is often sought through the installation of air conditioning or ventilating systems, though fly ash precipitators would be the more direct and simple answer.

Some industrial processes are extremely sensitive to impurities in the atmosphere and require a good filter system which, however, soon becomes highly inefficient in the presence of fly ash, requiring frequent washing and removal of filters, often with resulting curtailment of production while filter units are shut down.

Fly ash is very injurious to electric motors and generators, causing excessive bearing and commutator wear and clogging ventilating passages, while the particles of ash are often driven into and over the surface of insulated windings with great force by the action of fans on the rotor. Such action erodes the coil insulation with the result that frequent shut downs of a few days are required for the application of protective coatings of varnish to the windings. If this is not done, erosion will continue to the extent that windings fail, necessitating removal of machinery for many weeks from productive service while new coils are being wound.

Experience has proven that the introduction of an electrical precipitator between the boiler and its induced draft fan increases the life of the fan blades by at least 500%. The replacement of such blades usually requires a boiler shut down of several days with resulting delay in production.

In some plants, much of the equipment necessary to the plant is located out of doors, certain chemical apparatus, for example; furthermore, atmospheric air of reasonable purity is also required for the power cylinders of air compressors equipped with gas engine drive.

Some industrial plants have a great many miles of instrument tubing, most of which is exposed outdoors and usually fastened along walls, columns or pipes. Fly ash tends to collect between the tubing and the objects to which it is attached, thereby producing an acid moisture retaining material which greatly accelerates the corrosion of the tubing. In line with present day conservation, such tubing is of steel with thin walls, so that under the conditions cited frequent replacement of the tubing is required, with either tubing of copper or pipe of extra heavy steel.—*T. W. Reynolds*

Air Filters for Control of Air-Borne Bacteria

J. M. DALLA VALLE
American Air Filter Co., Louisville, Ky.

THE performance of ventilating systems is often judged in terms of equipment provided for controlling air-borne dust and bacteria. Dust elimination has been accepted as good ventilation practice for many years and the efficiencies of various methods in use are fairly well established. The control of air-borne bacteria is a recent development, and it is only natural to inquire regarding the conditions under which its elimination is warranted, the factors which in the future will determine standards of air cleanliness and the efficiency of existing dust control equipment for removing these bacteria.

In this brief summary of air-borne bacteria control, we shall discuss information thus far available and the results of some experiments made to determine the potential danger of warm air systems in spreading disease organisms. Methods of controlling the danger will also be discussed including those being employed for eliminating dust. It is recognized that there are as yet no positive criteria for determining when air can be considered relatively safe and in fact there exists little information concerning the many variables involved in the transmission of disease. It is indeed difficult to generalize conclusions drawn from work with specific bacteria under controlled conditions. These facts have often been minimized or completely ignored so that it is necessary to offer some critical comments. There is no question that air-borne bacteria control will assume more and more importance as evidence of its value increases. However, it is well to hold in mind the variables involved, and the lack of inadequate standards to gauge the performance of any system of control. In our discussion of experiments which follow, we merely stress *potentiality* of danger incurred by recirculating air. There is, of course, a great deal of indirect evidence that control of air-borne bacteria reduces cross-infections in hospitals, but the precise degree of effectiveness measured in terms of control-efficiency as absolute as that used for dust is still lacking. Thus, the present status of air-borne bacteria control may be said to have established the potential danger of infections and to have demonstrated that certain techniques can be used to reduce the danger. The problems remaining to be solved are not simple, although the application of control methods should not have to wait on their solution.

We may with profit review briefly the foundations of the science of air-borne infections. Since the classic investigations of Spallanzani and later Pasteur on spontaneous generation an increasing appreciation of the importance of the atmosphere as a vehicle for the propagation of disease has developed. It is now accepted by every schoolboy that once any sterile article of food is exposed to the air, contamination results. In the laboratory sterile agar spread in petri dishes soon develops colonies of bacteria which deposit on them. That air contains bacteria is therefore generally accepted. The accelerated interest developed in recent years can be attributed to many factors, but chiefly to the techniques of epidemiology, the improved methods of bacteriology and air analysis and the promotion of bactericidal equipment and substances. To Wells at the Henry Phipps Institute of the University of Pennsylvania we owe much for his system of approach to the air-borne bacteria problem in current use. His invention of the first efficient bacteria sampling device and the evaluation of ultra-violet light as a method of bacteria control are largely responsible for the many studies made of air-borne infections during the last decade.

With the possible exception of two investigations made by Wells, most recent work has concerned itself with the problem of cross-infections in hospitals. In such cases, populations can be diagnosed, segregated, and controlled and it becomes relatively simple to determine the effect of any program designed to reduce or eliminate air-borne bacteria. The use of ultra-violet light either as corridor barriers or as a bactericidal agent in ventilation systems has proved effective in reducing cases of cross-infection. Unfortunately, as regards evidence of similar benefits from control equipment installed in schools, office buildings and homes, few tangible results have been secured. This is probably due to the fact that an epidemiological study of a heterogeneous population is very involved and clear cut evidence almost impossible to obtain.

A valuable aspect of modern air-borne bacteria investigations is the emphasis placed on the control of nasopharyngeal organisms which are expelled by sneezing and coughing. These organisms are ever present in crowded places but are usually not found in outdoor air. The nasopharyngeal group are easily cultured and identified. They are generally associated with measles, influenza, the common cold and other diseases. The infections caused by their presence in air have been shown in studies made in England of epidemics, mainly of sub-clinical character, although none the less important in correlating them with the more serious cases specifically identified in some individuals. Justification of the potential disease-producing nature of the nasopharyngeal organisms has been summed up by Wells as follows:

A. During coughing and sneezing, minute droplets containing micro-organisms from infected surfaces may be ejected into the air.

B. Most of these droplets are sufficiently small to evaporate before they can settle to the ground, leaving suspended in the air minute residues.

C. Their nuclei, in which the micro-organisms remain viable for considerable periods, may drift in air currents like particles of cigarette smoke.

D. The air breathed commonly by the various persons congregated in a room or other enclosed space can thereby transfer organisms from one person to another and plant them upon the susceptible tissues of the respiratory tract.

The above facts are incontrovertible and their truth has been demonstrated time and time again.

As in the case of water purification a half century ago, the presence of a group of internal organisms, *B. coli,* was used as an index of potable water, so recently there has been proposed the use of a particular group of organisms, the alpha hemolytic group, to serve as an index of air purity. This group is formed in the nasopharyngeal region and its presence, once determined, indicates air pollution by allied organisms. While such an index would be valuable as a limit of air pollution to be tolerated, no one has yet proposed what this limit should be. Its importance is readily apparent since it would make feasible the design of equipment and installations with predetermined efficiencies a matter of some concern at the moment.

The use of the Alpha hemolytic group as an index of bacteria-free air was advanced by Wells, who although tacitly admitting the need for epidemiological data to establish such an index, nevertheless derived the following conclusion from his studies:

"Reasonable efforts to free air supplies from living organisms are justified in the light of general sanitary principles, and should not have to wait demonstration that nasopharyngeal infections can be reduced by sanitary air control to a degree comparable to the reduction of intestinal disease by pure water supply."

It is obvious that however desirable this objective may be, there is as yet no practical method of eliminating air-borne bacteria so effective that existing nasopharyngeal organisms in any occupied space are completely eliminated throughout the duration of space occupancy. Rapid development will come when definite standards are set and these should be based not upon the performance of the most powerful germicide, but rather on sound epidemiological study of what can be reasonably tolerated under all kinds of conditions with minimum danger of infection to all individuals concerned. This is essentially what has been done with regard to water supply, milk and milk products, foods, etc., where sanitary quality is judged in terms of bacterial indices.

Role of Ventilating Systems

Thus far it is clear from the discussion that air-borne bacteria constitute a potential menace in occupied spaces. It is also easily deduced from the foregoing that ventilating and especially air conditioning systems provided with recirculation may assist in spreading microbes from an infected source. Included with these systems are warm air systems for duplex and other multi-dwelling buildings heated by a single furnace. In order to provide tangible evidence of the potential hazard of ventilating systems in spreading bacteria, a study was conducted in a new three story laboratory building heated by warm air and provided with forced ventilation. Approximately 30% of the air was recirculated. A description of the building follows:

The building in question is of brick construction, three stories in height, and provides laboratory and office space for some 100 employees. Building dimensions are 150x50 ft and room dimensions average 12x20x10 ft. The heating system consists of tempering coils, fan, heating coils and is located in a sub-basement. Recirculated air is returned to a plenum located in the upstream side of the fan. Necessary regulating louvres are provided. Air leaving the fan is partly passed through the heating coils. The remainder is conveyed in a duct running parallel with the heated air duct, and both split midway of the length and extend upwards on either side of the corridor. On each floor are provided four plenum chambers each to take care of a quadrant of the floor area. Tempered and heated air enters each plenum and is mixed so as to provide the temperature required for the rooms in each quadrant. Thus, each quadrant is independent of the other quadrants in the same floors and other floors and a wide degree of temperature adjustment is possible to meet exposure and personal requirements. Each room is supplied with air through grilles located in the corridor wall near the ceiling. From 6 to 12 air changes per hour are attainable. Each door is louvered and air escapes through the main lengthwise corridor to a return air register located along the corridor wall in a line directly above the mixing plenum in the sub-basement.

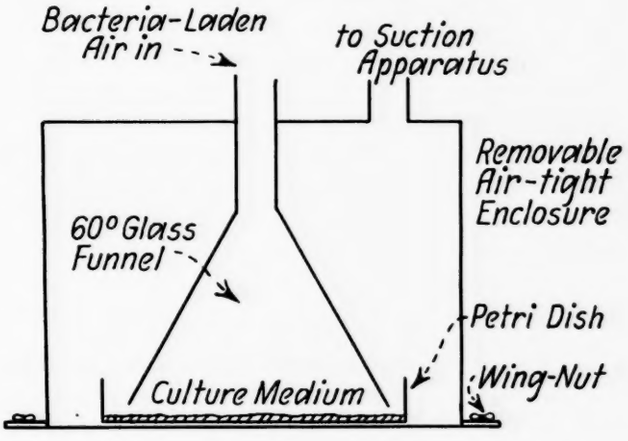


Fig. 1. Sampling apparatus used to obtain results given in Tables 1, 2 and 3.

This arrangement offers excellent opportunities to determine air-borne bacteria distribution after organisms are introduced in any given room. Tests were accordingly run using *B. subtilis* spores or hay bacillus. These were introduced in exceptionally high concentrations in a room on the second floor roughly 50 ft from the return air register. A centrifugal humidifier was used to spray the diluted culture in the room, but because of the high concentration present no attempt was made to determine the density of *B. subtilis* spores before they left the room on their way to the return air register.

The above test provided a severe concentration of air-borne bacteria and served to determine whether the bacteria distributed itself throughout the building.

B. subtilis is frequently found in air that is easily cultured and is a highly resistant spore. Its average diameter is about 2 microns, although in the droplet form in which it was introduced the size in suspension may have been greater. The sampling device used consisted of an inverted glass funnel placed over a petri dish containing the culture medium. These were placed in an air-tight brass compartment so that the air enters under suction at the rate of 1 cu ft per minute. A sketch of the apparatus is shown in Fig. 1. While this device did not correlate very well with the Wells' centrifugal method, it gave consistently higher values and was apparently more efficient in collecting *B. subtilis* spores. It also had the added advantage that it could be used to sample air in small ventilating ducts and especially to determine the efficiencies of dust filters described later.

With the ventilation system for the whole building operating normally, the results obtained are given in Table 1. These results are typical of many others obtained in the course of experiments.

The data given show conclusively how bacteria introduced in one room may be distributed to all other rooms of a building, heated or air-conditioned by the same system, provided of course a portion of the air is recirculated. No significance should be attached to the absolute concentrations other than the obvious relative comparison with the count secured before spraying began. Note that in the return air stream there is a steady increase in bacteria concentration as spraying continued, indicating that as the contamination and recirculation continue, there follows a gradual build-up of bacteria throughout the building. This is substantially what may be expected from an auditorium filled with people, or from a hospital ward containing infected individuals if the air supplied is recirculated to other rooms.

The building described above was not provided with air cleaning equipment. Tests were therefore run in an auditorium whose ventilating system was paper type dust filters. The results are given in Table 2, illustrating a remarkable reduction when bacteria spores *(B. subtilis)* were introduced upstream of the filter. The concentration noted is of the order found in fresh air during the tests run in the laboratory building above described, although "before" and "after" tests show no bacteria to be present. It is evident from the test data given in Table 2 that air filters are effective in reducing the concentration of bacteria. More data will be furnished later; sufficient to indicate here that the results presented in Table 2 were typical.

Table 1: Distribution of bacteria (B. subtilis) by ventilating systems having 30% air recirculation, following introduction in one room of a three story building. (Bacteria sprayed between 1:00 and 3:00 pm)*

Room Location	Time	No. Bacteria per 10 Cu. Ft.†
3rd floor S	10:20 am	2.2
3rd floor S	2:15 pm	47.7
3rd floor N	10:20 am	4.0
3rd floor N	2:45 pm	46.7
1st floor S	9:20 am	12.0
1st floor S	1:10 pm	17.0
1st floor N	9:20 am	2.0
1st floor N	1:10 pm	20.0
Return air going to plenum..	10:20 am	2.0
	11:15 am	7.8
	1:10 pm	21.1
	2:15 pm	36.7
	2:45 pm	60.0

*These data and those given in Table 2 are taken from a paper by DallaValle and Hollaender, "A Study of the Role of Ventilating Systems in the Transmission of Bacteria." Public Health Reports *55*:1268-1272 (1940).
†Average of triplicate samples.

Air-borne Bacteria Removal by Dust Filters

The effectiveness of dust filters led to an overall examination of these devices in removing air-borne bacteria. Here again, droplets of *B. subtilis* spores were used after they were elutriated so that droplets larger than 10 microns were not in suspension. Most of the filters used had dust efficiencies by the ASHVE test of over 90%. These efficiencies are on a weight basis, whereas the bacterial efficiencies are based on colony counts and are, therefore, not strictly comparable. The data obtained are given in Table 3. It is seen that with the exception of glass fabric the other materials tested were capable of removing from 63 to 85% of the droplets containing spores. These values are not as high as might be expected with electrostatic equipment, which in many ways is excellently suited for bacterial removal, but they are surprisingly larger considering the size of the droplets and spores.

In order to bring out the full significance of these tests it seems worth while to discuss the variables which must be considered. The concentrations of bacteria used were far greater than those which would be encountered normally. Moreover, there is some question relative to the efficiency of the sampling technique at high and low concentrations. There is no absolute method for sampling bacteria, so that the efficiency of any sampling method over all ranges of concentration remains unsolved. Moreover, bac-

Table 2: Effect of air filter on restraining bacteria* (B. subtilis) introduced in ventilating system of unoccupied auditorium 58 x 44 x 14 ft provided with 14 air changes per hour, and 30% recirculation.

Point of Bacteria Introduction	Time	Average No. of Bacteria in Auditorium per 10 Cu. Ft.
Down stream of filter ..	Start	None
Down stream of filter ..	15 min. later	21.9
Down stream of filter ..	60 min. later	None
Up stream of filter	Start	None
Up stream of filter	15 min. later	3.7
Up stream of filter	60 min. later	None

*Bacteria sprayed for 5 minutes and samples taken immediately after.

Table 3: Efficiency of certain commercial air filters against bacteria (B. subtilis). (Droplets elutriated and less than 10 microns in size. Velocity through filters 1000 lfm.)*

Type of Medium	Efficiency†
Felt cloth	63.5 ± 6.5%
Felt cloth	67.3 ± 6.5%
X-ply paper (treated)	74.8 ± 5.6%
Y-ply paper (treated)	75.5 ± 8.0%
Steel wool (oil coated)	82.9 ± 7.6%
Steel wool (oil coated)	85.4 ± 9.5%
Glass fabric	32.6 ± 8.3%

*These data are from a paper by DallaValle and Hollaender, "The Effectiveness of Certain Types of Commercial Air Filters Against Bacteria *(B. subtilis)*". Public Health Reports, *54*:695-699 (1939).
†Average of not less than 9 samples.

terial sampling is more complicated than dust sampling. In the former several facts must be considered, the important ones being: (1) The sampling device should not injure bacteria collected; (2) The sampling tube or entrance to the culture media should be as short and direct as possible to prevent deposition of bacteria, and (3) The media used for propagation of colonies should be as specific as possible for developing the particular bacteria sought. The first two items constitute mechanical features. The last is purely bacteriological, but is of importance since it is often difficult to provide a medium which is specific for a single group of organisms unless further work is done with the bacteria collected by a competent bacteriologist.

With further reference to the efficiency of air-borne bacteria sampling devices, we may mention that it is not easy to capture bacteria of the order of two microns and smaller. The significance of Wells' tests and those here recorded depend pretty much on the fact that droplets of sizes much larger than bacteria are captured. Single bacteria or spores in a dry state pass through the sampling devices and fail to be impinged or precipitated except largely by chance. The forces which would be required to capture suspended bacteria would be so great as to destroy them. At present we can only follow Wells fundamental hypothesis that the detection of certain nasopharyngeal organisms in droplet form are an index of air pollution.

Critical Aspects of Air-Borne Bacteria Control

As in the case of dust control, it is apparently a desirable objective to remove every microbe from the air we breathe. But also, as in the case of dust, this is practically impossible, and in many respects more complicated and difficult. As we have stated, it is a simple matter to sample dust and stipulate the efficiency of an air cleaning device since we do not distinguish one kind of dust from another present in the air at the same time. This is not the case in sampling bacteria. Each group of organisms requires a separate media on which it must be cultured. Hence, any method used must distinguish, or at least identify, the kind of organisms sampled.

It is because of the facts here mentioned that the subject of air-borne bacteria control is at present confused and intangible. This does not imply that existing control methods are ineffective, but that many claims made regarding their germicidal attributes for the whole gamut of air-borne bacteria, ignore the limitations of bacteriological science to substantiate them.

In general there are four methods which may be used for controlling air-borne bacteria. These are: (1) Dust filters, (2) Electrostatic precipitators, (3) Ultra-violet rays, and (4) Chemical germicides. The first two methods require a controlled air flow and the same action which captures or precipitates dust is capable of restraining bacteria. Not all dust filters are of equal efficiency in collecting bacteria droplets as we have shown. For *B. subtilis* spores efficiencies were generally found to be between 63 and 85%. No data are available with regard to the efficiency of electrostatic precipitators, although it is well-known that the efficiency of these devices is high for particles less than 10 microns in size. Bacterial efficiencies, therefore, should be expected to be higher for electrostatic precipitators than for filters. They are widely used in breweries and in the preparation of serological supplies where air-borne bacteria must be kept at a minimum. It may be mentioned that in the preparation of tissue cultures, sterilized paper air filters have been found effective.

Ultra-violet light is effective in controlling many types of air-borne bacteria. It is generally used in the form of a barrier in hospital corridors to prevent the spread of infections, or inserted in the air-supply duct. It must, of course, be used in a concealed form because of its effect on the eyes and skin. When inserted in an air-supply plenum or duct, the air must move slowly so that all bacteria coming within the radiant field are held long enough to be destroyed. Ultra-violet radiation is not very effective in destroying bacteria contained in dust particles. Furthermore, the efficiency of ultra-violet lamps is reduced if dust deposits on the lamp surface. Very intense fields also produce ozone which is objectionable in ventilation and ions which attach themselves to dust and water nuclei, causing them to remain in suspension longer than if they were not so charged.

The effectiveness of ultra-violet for air-borne bac-

teria control depends upon intensity of radiation, wave-lengths covered, distance from bacteria, and duration of contact with bacteria. Wave length is important since it seems well established that bacteria are particularly responsive to different kinds of radiation. Lethal radiations vary over a wide portion of the light spectrum and every organism has a specific wave length which destroys it readily. However, in general, ultra-violet has given good results.

We come finally to the use of chemical germicides which are relatively new. Good results are claimed with this technique. Low concentrations of the germicidal agent may be sprayed into the ventilating system, or what is a very definite advantage over the other methods described, used directly in an occupied room without controlled ventilation. The effective concentrations are usually below the threshhold limit of odor and do not affect the individual. However, in unventilated rooms there is always danger that obnoxious concentrations may accumulate in time.

The precise action of such low concentrations of chemical germicides is not known. Tests thus far have been made with droplet "inoculations" in a controlled air supply and results reported are excellent. Undoubtedly, the bacteria-laden droplets combine with the droplets of the germicide and the effect is the same as though each bacterium were placed in a solution of the germicide itself. Surface phenomena may also play a part, although, as we have said, the precise action remains to be discovered.

Whether chemical germicides exert any action on "dry" bacteria or spores is also not known.

Before bringing this article to a close, it is perhaps well to discuss briefly the methods used for determining the effectiveness of devices for air-borne bacteria control. Two methods are usually employed, the first involving more or less control of the variables outlined above. The second method is epidemiological and comprises studies of the effect of control equipment on the well-being of representative groups of people. Both methods are complementary and eventual acceptance of control equipment requires that the results of both methods be favorable.

The laboratory approach utilizing controlled conditions is valuable because it is quantitative as well as qualitative. It reveals the relative importance of the variables and what should be done in designing more effective apparatus. It may utilize experimental animals or persons for subjects. However, the scale of experiments is small, subject to errors of technique, and other difficulties due to personal inability to foresee all circumstances under which equipment may be used. For example, while we may render the air supply to an occupied room free from all bacteria, it does not necessarily follow that the room air itself will be free from bacteria. Some persons will cough or sneeze, and dust partly laden with bacteria will undoubtedly be shaken from the clothing or the floor and walls by individual activity or building vibrations. While the concentration of bacteria will be lower than that existing without control, there will still exist a potentiality for spreading infections. Bacteria-free air supplies would be expected to work best in hospitals where similarly infected individuals can be segregated from others, or in places where the density of population is small, and the air spaces available for dilution great. Thus, except in a few instances, the laboratory approach is limited.

The epidemiological approach may be termed an integration of practical experience. This method of

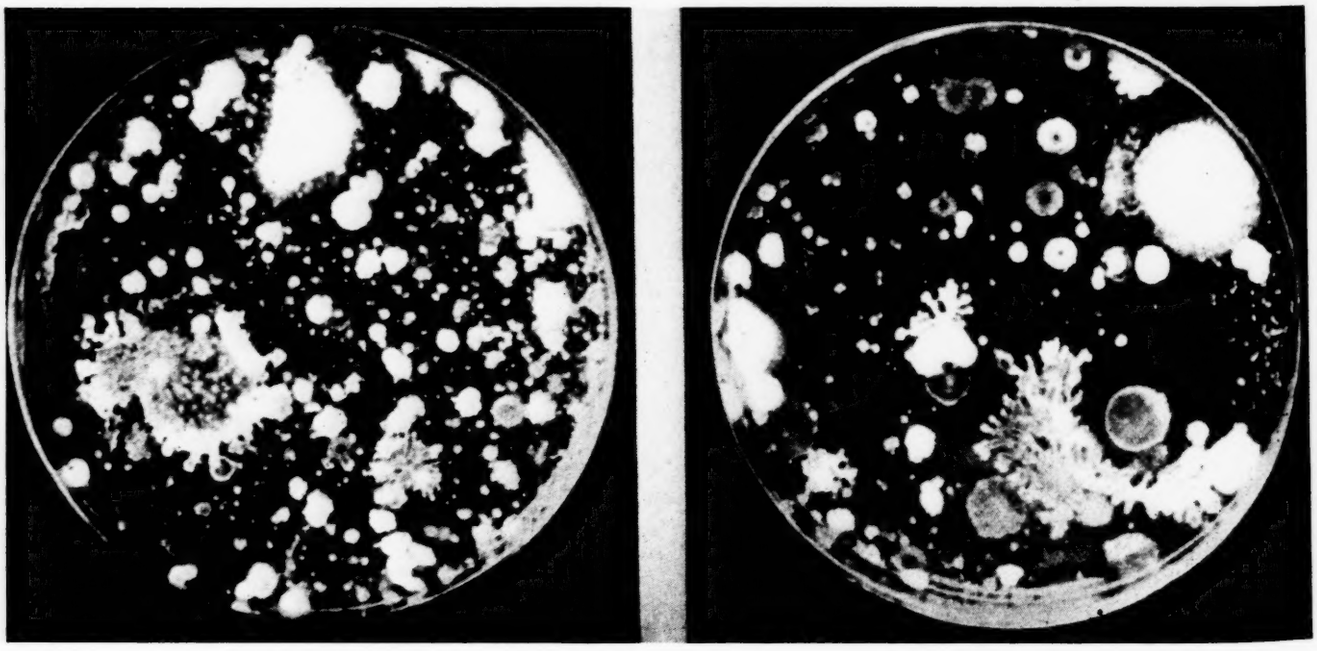


Fig. 2. Photographs of petri plates showing mold spores and other micro-organisms in ordinary outdoor air. (Photographs courtesy University of Wisconsin).

investigation is based on studies of two groups of individuals, one of which resides in an environment in which, say, air-borne bacteria are controlled and the other in an uncontrolled environment. Both groups should be similar in age distribution, sex, economic status, and performing if possible identical or similar activities. Once this has been done, a careful record is made of all illnesses occurring in both groups. A comparison of the incidence and severity of illnesses will reveal whether the bacteria controlled environment is healthier. Of course, "before" and "after" studies may reveal the same result, but it is always difficult to eliminate the time factor and results are not strictly comparable.

Epidemiological studies make no attempt to control variables. They are usually of long duration, taking account of seasonal factors, and must consider inherent differences in the groups studied. This method has been used in hospitals with good success, but its application to office or factory groups has not been noteworthy as yet. The relatively small fraction of time spent by the group in rooms where air-borne bacteria are controlled—the remainder being spent in the same fashion as the other group—does not produce clear-cut results. A comparable epidemiological study of two office groups working 40 hours each week in air-conditioned and non air-conditioned rooms produced no significant differences in illness recorded. Therefore, we see that the epidemiological approach is subject to many difficulties, although when carefully conducted it is a most valuable method. In the final analysis, this method will determine precisely the benefits of air-borne bacteria control and the conditions under which it should be employed.

One further matter deserves mention. There exists an opinion that the normal flora of the air is beneficial, and that its elimination reduces the opportunity for the human system to build up antibodies so important in fighting disease. There are some immunological grounds for this contention. However, it should not be a matter of concern at this time, since there is no general use of air bacteria control equipment, and so long as individuals continue to mingle together, the argument cannot be considered a serious one. It is not so many years ago that many frowned on "artificial" weather, but today there are physiological data to show that within proper limits it is not only beneficial, but improves comfort and working efficiency.

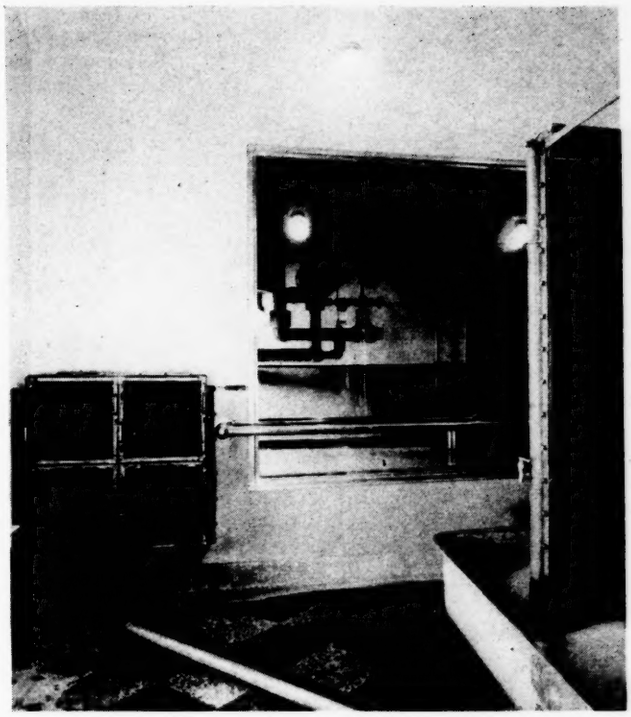


Fig. 3. Viscous filter unit to provide bacteria-free air for beer cooler room.

Conclusions

In the foregoing discussion we have shown that the science of controlling air-borne bacteria requires further development before general claims are made for it. While air is proved to be a vehicle for distributing bacteria, especially by ventilating and air-conditioning systems with recirculation, the science has not progressed sufficiently to prove that there is a method which is preferable to all others. Dust filters and precipitators are effective against bacteria droplets when it is considered that at the present time no occupied space can be made bacteria-free. Much depends upon occupancy density and air volume per person. While studies must continue, the use of air-borne bacteria control should not wait upon them. The evidence so far produced shows conclusively that air-borne bacteria are the cause of many common diseases, and that most of these bacteria can be controlled.

How Many Heating Plants Are There?

An estimate of 7,000,000 residential structures heated with warm air furnaces, 15,400,000 residential structures heated with stoves, 4,150,000 heated with boilers, and 2,750,000 with no heat, has been made by K. C. Richmond, editor of *Coal Heat*, and published in a series of articles appearing in that publication. In addition, Mr. Richmond estimates that there are 50,000 boilers in apartment houses, making a total of 4,200,000 boilers in residential-type buildings, including houses and apartments.

Mr. Richmond further estimates that there are approximately 1,500,000 boilers in institutional, commercial, and industrial buildings; there are also thousands of warm air furnaces and stoves in the country's rural schools. His total estimate, then, is that at the present time there are about 5,700,000 boilers in use in this country, 17,500,000 heating stoves, and 7,400,000 warm air furnaces.

Part of the modern, windowless and completely air conditioned machine floor of Woodward Governor Co.

R. P. DEWEY
Woodward Governor Company, Rockford, Ill.

Close Machine Tolerances Possible Through Temperature Control

DURING the past three quarters of a century, requirements for close speed regulation of prime movers has become consistently greater and during the last decade, the increasing use of water power and diesel engines for generation of electric power has made necessary the constant refinement of speed control mechanisms. The refinements needed to obtain the exacting control required on these large, and sometimes automatic, generating plants have made necessary the constant improvement of designs and a continual effort to manufacture parts to more exacting tolerances. Quantity production makes interchangeable parts a necessity and the higher duty requirement of all assemblies drastically limits manufacturing tolerances allowable for satisfactory parts. The advent of adjustable pitch airplane propellers has demanded high precision parts in airplane propeller governors, and the factor of complete interchangeability and constantly increasing production has placed stringent demands on the manufacturer. Since the original development ten years ago, this business has multiplied many times, having taken, in the last two years, a major position in production, because of the war demands for fighting aircraft.

In the manufacture of hydraulic governors it is necessary to hold mirror-like finishes and tolerances of only (.0002) two ten-thousandths of an inch on many parts so that, for example, fits between pistons, piston valves, etc., and mating cylinders will allow for minimum leakage and at the same time operate with as little friction as possible. Parts of this caliber, made on a production basis and entirely interchangeable, require close supervision and exacting manufacturing methods. But with the best of methods, in order to maintain such tolerances, it is obvious that constant temperature conditions must be held and that dust and dirt be excluded from the manufacturing areas as much as possible. Furthermore, it is necessary to maintain the relative humidity below certain limits to prevent rusting of parts in inspection and on other "dry" operations. This can best be understood when one considers that when taking two such parts and subjecting one of them to a temperature change of 20F to 30F that the parts either will not go together or else be such a loose fit that they will not pass the required inspection.

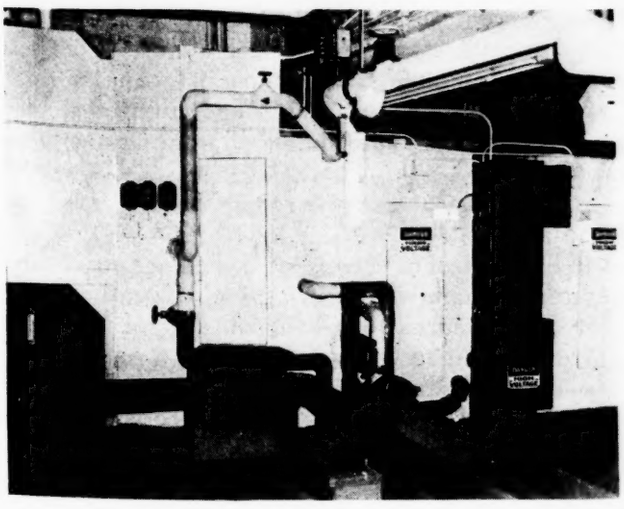
Many Types of Governors Made

The Woodward Governor Company, Rockford, Ill., has been in the governor business since 1870, and has manufactured hydrauiic governors since 1911. In 1933 they developed the first successful governor for control of adjustable pitch airplane propellers. They have just recently completed the first year of occupancy in their new plant, which was built for the purpose of maintaining extreme accuracy of manufacturing tolerances and providing the best of facilities and surroundings in which their members should work. They are now manufacturing governors for water wheels, diesel engines, steam engines, steam turbines, aircraft, and for many other applications for regulation of power sources being used in the war effort. The management of the Company showed far-sighted wisdom in building the

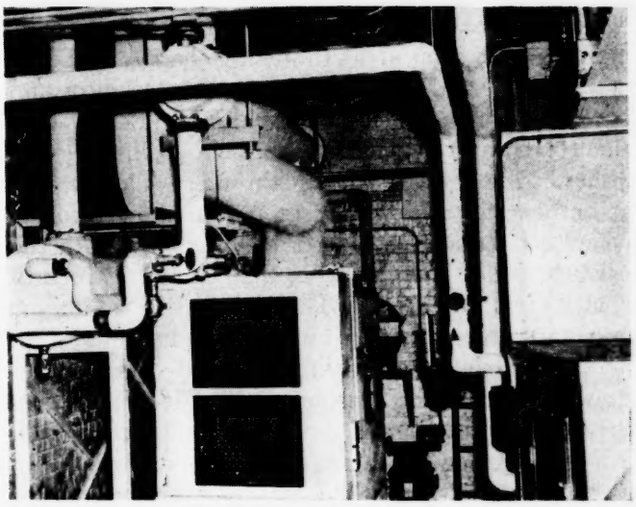
new plant to plan for the necessities of exactness for manufacture of their precision products as well as for the comforts and convenience of their members. The first year's operation has demonstrated the wisdom of the original planning.

The 145,000 sq ft of floor space consists of three units of concrete and brick construction with brick and Lannon stone veneer. The buildings are windowless, except for glass brick panels in front for decorative purposes only, and the entire offices, machine shops, laboratories, auditorium, locker rooms, cafeteria, etc., are completely air conditioned and with the ceilings of acoustic tile. The floors in the offices are of sponge rubber, which assists in keeping a low noise level. The machine shop floors are terrazzo with alundum chips so that they will promote cleanliness, safety as well as ease of maintenance.

In all the machine shops, all the services (electricity, air, etcetera) are carried under the floor and through fittings direct to the machines which, incidentally, are all mounted on felt padded leveling blocks, but are not fastened to the floor. All lighting, except in the auditorium where dimming is desired, is by fluorescent tubes, which are serviced from above or below, the fixtures being interchangeable with the acoustic metal tiles in the ceilings so that they can readily be increased or decreased in number. The light intensity is approximately 140 foot candles in the engineering and design departments and about 45 foot candles in the machine shops. A central call system includes loud speakers installed in the ceilings at regular intervals throughout the plant, the system being used for paging as well as broadcasting music, notices, etcetera. The cafeteria, operated by the company members, serves hot meals throughout the twenty-four hours of the day; and shower baths, a modern sun lamp room, first aid and therapeutic treatment rooms are provided for benefit of all workers.



Fresh air intake end of one part of air conditioning system showing external control units for electrostatic precipitator, control valves on steam and water coils, thermostats, and condensate meter.



South fan room with control valves, condensate meters, and humidifier-dehumidifier unit with regeneration equipment. Dry filters are auxiliary to electrostatic units.

The air conditioning system utilizes water from one 12-inch and one 16-inch well, both 700 ft deep, for cooling after the air is passed through self cleaning electrostatic precipitation type filters and lithium chloride humidifier-dehumidifier units. The lithium chloride solution is utilized in a continuously regenerated cycle and all the fresh air entering the building passes through these units. Both fresh air and the small amount of recirculated air pass through the electrostatic filters and some of the recirculated air is also passed through throw-away type of air filters.

Five Fan Units Used

Five fan units are employed in the system; two for the main machine shop, one for the basement shop, one for the office and one for the auditorium. The ducts of the latter two units are interconnected so as to use both of the systems for the auditorium if necessary. Duct work is of the moulded asbestos type which was chosen for ease of installation and because of its noise reducing qualities. The total volume of air handled is about 213,000 cfm, including recirculation, and the cooling load amounts to in excess of 300 tons. Due to the very low building losses, however, cooling is required even at very low outside temperatures. The office portions of the building under normal occupancy and operating conditions are maintained at comfortable temperatures without heating with outside temperatures as low as —3 to —6F. With the machine shops fully manned and with machines in operation, calculations show that these portions of the building would be held to desired comfort conditions with outside temperatures as low as —45F without heating. These figures assume, of course, the heat gain from machines and personnel as well as the gain from lighting and the humidifying system. It will be obvious from these figures that the only time heat would be needed in the building would be when it was virtually unoccupied.

Conditioned air is supplied to all office, engineering and main shop areas through ceiling type diffusing outlets and the supply to the auditorium, basement shop, toilets, shower rooms and some small laboratory spaces is through diffusing type grilles. All exhaust is taken through grilles located at or near floor levels except in the shower rooms where ceiling supply fixtures are used, but with the exhaust grilles placed also in the ceiling to properly vent vapors and steam. The locker room is unique in regard to ventilation and air conditioning since here the air is supplied through ceiling fixtures and drawn through the louvers in the lockers, down through the perforated bottoms and out through exhaust ducts which form the bases on which the lockers are installed. This feature keeps the locker room and the lockers entirely free from odors and serves also to rapidly dry out any damp clothing placed in them. Electric temperature regulation is used throughout with practically all controls of the proportioning type. Steam for process work and regeneration of the lithium chloride systems is obtained by means of two scotch marine oil burning boilers, and all condensation is returned through condensate meters so that accurate records of steam use can always be kept.

Operation of all controls, fans, lights, etcetera, is centralized on a boiler room switchboard which shows by means of pilot lights the functioning of all apparatus relative to the air conditioning system and provides master control for blackout of lighting, air raid warnings and all pumps, emergency lights, etcetera. An engine driven generator is located in the boiler room which automatically starts on power failure to the plant, so as to provide current for pilot circuits.

Fuel Conservation in Industrial Buildings

The principal sources of reducing heat losses or heat recovery in many industrial plants are in (1) general over-all efficiency and careful operation of heating plants; (2) reduction of air normally exhausted to the outdoors, which in turn requires a volume of make-up air (to be heated during cold weather) equal to the volume exhausted; and (3) utilization of exhaust steam from drop hammers, and other steam driven apparatus. In winter, air is heated, circulated and discharged to the outdoors, while in summer it is cooled and discharged; both require energy. Reducing the amount of air exhausted saves fuel.

The ventilating system in one midwestern aircraft plant is equipped to recover 200,000 cfm which normally would have been discharged to the outdoors. Recovered air is then filtered, based on health requirements. This volume of air reclaimed in cold weather represents a saving of 12,000 lb of steam per hour or an equivalent of 18 tons of coal per day. This also eliminates 20,000,000 Btu capacity of heating apparatus, and the savings estimated this season are 3,000 tons of coal and 600,000 ton-miles of transportation.

The program for industrial feeding, calling for increased facilities in war plant cafeterias, rest rooms, etc., will affect thousands of plants. These represent the type of spaces that are responsible for high volume, non-process exhaust losses that reflect so heavily in fuel and power consumption.

Losses from exhaust fans should be reduced to a minimum. It is estimated that with average heating design conditions in the New York district, a 12 inch free delivery exhaust fan running 24 hours per day would entail a consumption of approximately 17 tons of coal per heating season.

Exhaust steam should be utilized wherever possible for winter heating. If necessary to reduce back pressure, water may be heated for recirculation to remotely located heating equipment. In one plant where this system is used, 60,000 lb of steam per hour are saved, which is equivalent to 90 tons of coal per day. It has also been observed that many industrial plants are careless about returning all the steam condensate to the boilers, and it is not uncommon to see a considerable amount drained to the sewers. These conditions should be corrected, not only for savings in fuel, but also to economize in quantity of water, pumping charges, and feed water treating.

There are over 1700 Government owned defense plants, about 1200 of which are the type which offers broad opportunities for the conservation of fuel. The following information will be obtained to determine possible economies that could be effected:

1. Average quantity and temperature of air exhausted per minute from October 1 to April 1.
2. Average quantity and temperature of air per minute introduced into the plant from October 1 to April 1.
3. Quantity of exhaust steam discharged to the atmosphere.
4. Square feet of floor space heated and what temperature is maintained.
5. How condensate is handled.

Three Points to Check:

While individual installations may have other problems, most plants can cut heat costs and save fuel by observing simple precautions: 1. Exhaust the *minimum* amount of air needed for oxygen replacement; 2. Use a maximum of exhaust steam for heating purposes; 3. Return a maximum of steam condensate to boilers.—*Davis M. DeBard, Deputy Director, Conservation Div., War Production Board*

Weather Trends Indicated by Degree-Day Study

RAYMOND LITTLE
Utilization Engineer and Commercial Manager, Equitable Gas Company, Pittsburgh, Pa.

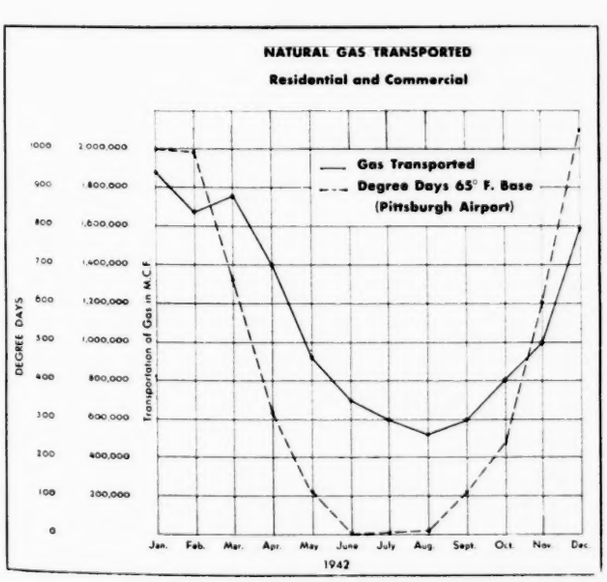
By a study of degree-day data over a long period the author reveals some interesting weather trends for several localities. Abstracted from an article is the first paper resulting from the work of the National Joint Committee on Weather Statistics, made up of representatives of societies and associations concerned with the degree day unit, and on which Mr. Little represents the American Gas Association.

IT IS commonly known that the number of degree days over any given period is the summation of the daily differences between 65F and the daily mean of the maximum-minimum temperature. The basic figure of 65F represents a daily mean temperature indicating a daytime temperature of 70F and a night temperature of 60F.

While the primary purpose of establishing the unit was for checking fuel bills and estimating or forecasting fuel consumption, it is of interest to consider other ways in which it has proven of value not only to the gas industry but to district steam companies, as well as to all concerned with fuels and space heating. In Fig. 1, the 1942 accumulation of degree days for the Pittsburgh area is plotted with respect to the transportation of residential and commercial gas in thousand cubic feet. Curves and data similar to this are used thoughout the gas industry as an aid in predicting fuel requirements at any time during the year. When a normal degree day accumulation for an area has been established and the course of mean temperatures observed for a number of years, then heating fuel requirements can be predicted accurately if base load requirements are known. Thus in the gas industry with the aid of weather reports and predictions it is possible to anticipate transportation requirements and storage pool or reserve requirements for the residential and commercial markets. This knowledge is a valuable guide to management in planning for seasonal requirements and in estimating the volumes of gas available for delivery to the industrial market.

A second chart frequently used to advantage by the sales or promotion departments of gas utilities is illustrated by Fig. 2. As indicated, the heating season's normal degree day accumulation for the Pittsburgh area is shown as an example. In addition, the degree day accumulation for the preceding year is plotted and finally the same curve for a current season. This material is made available to all sales offices and is useful in comparing the preceding winter with the current winter to date while at the same time showing departures from normal weather. The information is of value in answering high bill complaints and is often instrumental in justifying an apparent high bill or disclosing heating plant trouble causing inefficient operation.

A curve of this kind also indicates the percentage



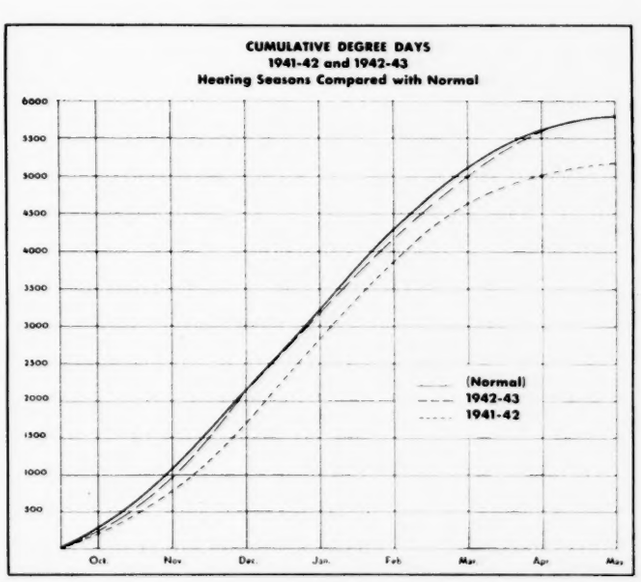
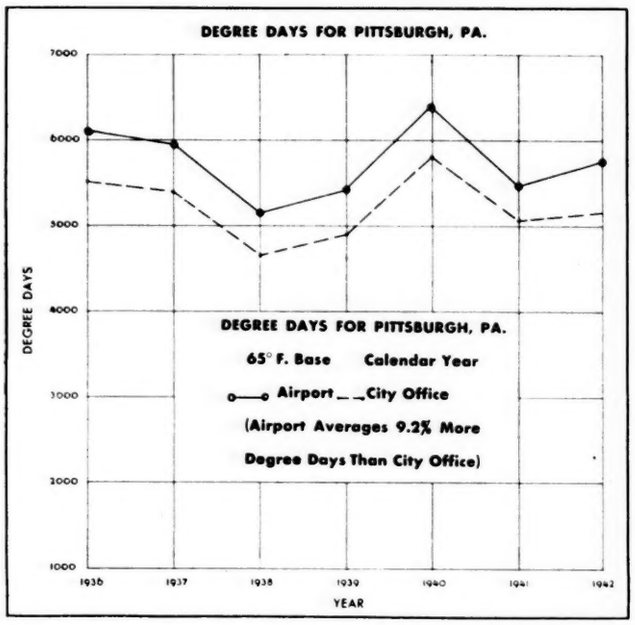


Fig. 1. (Left) Degree days in Pittsburgh for 1942, plotted against transportation of residential and commercial gas in that city. Fig. 2. (Right) Cumulative degree days for Pittsburgh for two heating seasons compared with the normal.



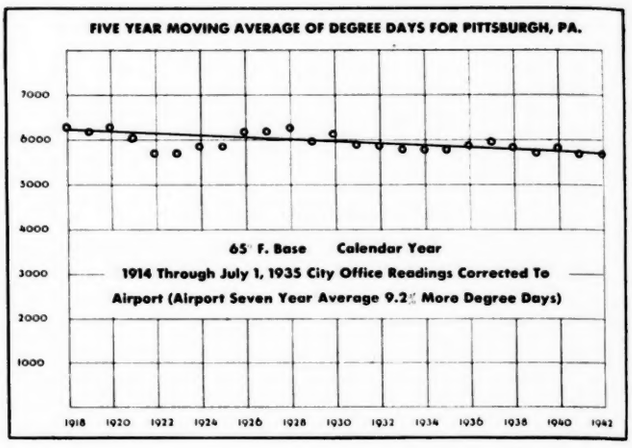


Fig. 3. (Left) Degree days for Pittsburgh as taken at the city office and at the airport for seven heating seasons. Fig. 4. (Above) Five year moving average of degree days for Pittsburgh showing the tendency toward warmer weather.

of the heating season that is past or yet to be encountered as of any date. This is true because, with only rare exceptions, cold weather accumulation in any heating season will closely approach a well founded normal pattern. Therefore, if the fore part of a heating season is below normal or moderate, then it can be anticipated that the remainder of the season will be colder than normal. A curve of this nature is also helpful in anticipating load requirements for a current season and guides operating management in making provisions for holding peak load natural gas in reserve or maintaining stock piles for manufactured gas.

Gas companies and others operating in a particular area or zone can easily check on weather variations peculiar to the zone in which they serve. Often it is found that certain spots in an area are colder than average or normal. In fact, evidence is on hand to make it safe to say that the metropolitan area of a large city shows a warmer atmosphere than suburban or outlying territories around the city. This condition is reported by New York City, Chicago, Detroit, Pittsburgh and elsewhere. Fig. 3 shows a seven year comparison for degree day accumulations in downtown Pittsburgh and at the airport about twelve miles out. As indicated, there is a 9.2% higher average at the airport and since most gas consumers live outside of the city the higher figures are used for estimating purposes. On the other hand the district steam heating company is interested in the lower figures only.

Warm Weather Trend

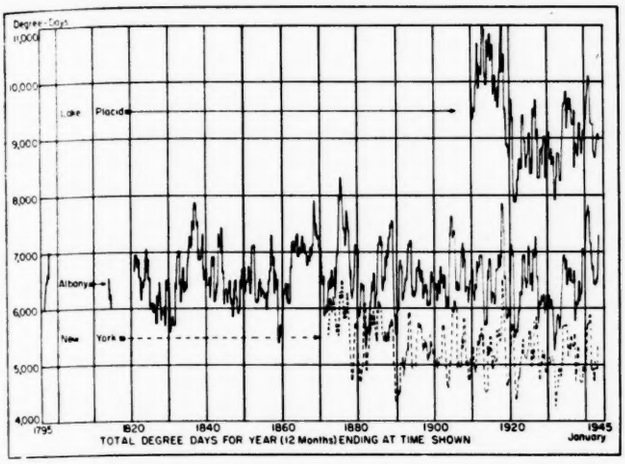
Weather observations in numerous parts of the nation over the past few years indicate that the atmosphere is getting warmer. These observations lend credence to the often heard claim that winters are not as severe as they were in days gone by. The use of degree day accumulations over the years has been very helpful in the study of this situation. For example, Fig. 4 is plotted on the basis of a five year moving average over a period of time from 1914 to 1942. The mean line drawn through the points plotted indicates a warming up of the atmosphere of approximately 10% in this period of thirty-eight years. To date, such evidence cannot be taken as conclusive because, for one thing, the taking of meteorological data has been refined continually through this period of years. Also this may be a phenomenon of weather that cannot be verified until more years of experience are available; it may be a weather cycle that will change in direction every forty or fifty years. However, the development of the degree day unit makes it simple to observe the course of weather in this respect.

In order to amplify the information just quoted on the weather at Pittsburgh, Stanford Setchell, assistant engineer of utilization, American Gas Association, computed weather data for three locations in New York State: New York City, Albany, and Lake Placid.

Calculation of the Degree Day Data

Where available, monthly degree-day totals as published in HEATING AND VENTILATING were used. Where these figures could not be obtained, the monthly degree days were calculated from the mean monthly temperatures furnished by the United States Weather Bureau. These monthly mean temperatures were converted to monthly degree days by subtracting the monthly mean temperature from 65F and then multiplying this difference by the number of days in the month. This procedure varies slightly from the more usual one of computing the degree days day to day. The error, however, is small, in no case exceeding 3%, and the work of computation is much simplified.

The purpose of calculating the degree days over the longest possible periods was to disclose the existence of definite weather trends, if indeed such exist.



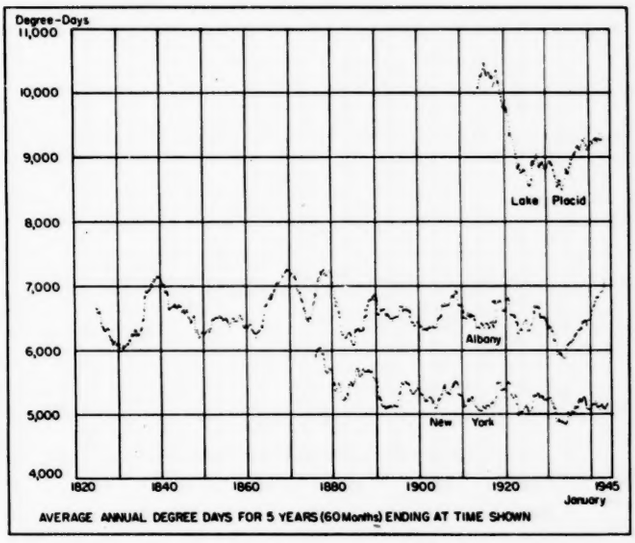


Fig. 5. (Above) Variations of degree days on a moving average basis for New York, Albany and Lake Placid. Fig. 6. (Right) Cycles in annual degree days are indicated in this chart covering the same locations as Fig. 5.

One useful scheme for showing the presence of trends is the simple mathematical process known as the moving average, obtained in these calculations by successively adding the data for the next month while subtracting a month at the beginning. Thus the degree days are obtained first from January through December, then February through to January, March to February and so on. The interval between the end months was first taken as one year —then the process was repeated with five years* and finally with twenty years between the ends.

The results of these computations have been plotted in Figs. 5, 6, and 7. The effect of the longer intervals can readily be seen for the curves† smooth out and the minor variations disappear so as to reveal long-term trends if they exist.

Weather Trends Indicated

The gas industry has always hoped that definite weather trends could be found so as to assist in the prediction of future loads. There also was some hope that the weather was getting warmer, so that house heating peaks would become somewhat less severe in the future. To a limited extent, since only New York, Albany, Pittsburgh, and Lake Placid are covered in this paper, the answer to these hopes is revealed.

Fig. 5 shows the very great variations in heating requirements as the moving average moves forward month by month. Within the space of a few years, variations of 30% or 40% may occur. Great variations from one winter to another are shown and the weather in one winter gives no clue whatsoever to the weather in the next. In large measure the Albany and New York curves rise and fall together. The Lake Placid curve agrees with the other two in some respects, but is different in others. Apparently, the distance from the other stations and the location in the mountains produce a somewhat different climatic behavior at Lake Placid from that of the other two locations.

Fig. 6 shows certain pronounced cycles. At Albany there are pronounced peaks in 1839, 1869 and 1878, and another seems to be developing in 1943. New York seems to have a corresponding peak in 1878, but there is no sign of one in 1943. Lake Placid has a very pronounced peak in 1915-17 while both Albany and New York have valleys at that date. Lesser peaks are noticeable at Albany and New York for 1888, 1897, 1908, 1918-20, and 1927. There appear to be cycles about ten years in length.

In Fig. 7 the short-term variations have been largely eliminated and certain long-term trends are indicated. The Lake Placid data do not go back far enough for any conclusions to be drawn except that the weather at that locality has grown warmer over the relatively short period covered. At Albany the climate apparently grew somewhat colder from 1820-1855. During the next eight years the weather got somewhat warmer. It became definitely colder toward 1882, and then warmer to 1900. For the twenty year periods ending from 1900 to 1930 there was little change in the weather. From 1940 to date it grew somewhat warmer and then colder again. In other words, for the last 60 years or so there seems to be little change in the Albany climate. In New York City, on the other hand, the weather appears to have grown warmer almost continuously from 1871 to date. One theory advanced for the warmer winters in large cities is the increasing amount of fuel used in those cities and their increasing size. This would tend to raise the city's temperature even if the surrounding climate remained the same. The above comparison between Albany and New York seems to lend weight to this contention. However, there might be other contributing

*Naturally the five and twenty year figures were reduced to annual averages by dividing by 5 and 20 respectively.

†Though shown as curves, these are really points lying so close together as to resemble a curve. Each point on Fig. 6 represents the average annual degree day value for a 5 year period plotted at the end of the period covered. On Fig. 7 the points are plotted at the end of 20 year periods. Thus the first point shown (Dec. 1839) is the 20 year average annual degree day data beginning with January, 1820.

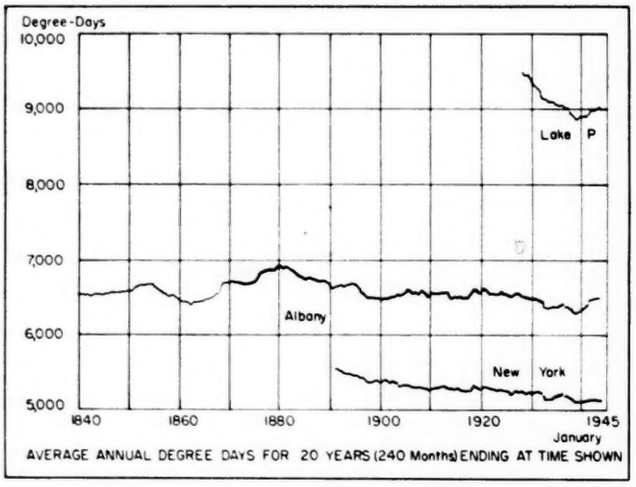


Fig. 7. Short term trends are eliminated in this plotting of degree days for the cities also shown in Figs. 5 and 6.

causes for these differences, such as New York City's seaboard location compared to the inland location of Albany. The marked drop at Lake Placid is interesting since this is a small rural community where the effects of man-made heat are very small.

Work on the data from these three locations points to certain interesting indications, but they should not be accepted as conclusions without similar confirming data from a number of other locations.

65F Base Satisfactory

In the course of the Committee's discussion the question was raised as to whether 65F was a well founded base for all parts of the nation. It was thought that in the southwestern part of the United States a 65F mean or base was too low. As a result of this discussion the writer was requested to make inquiries through the A.G.A. by asking member companies in the southwest to give their views on this matter. Information was received from Texas, Arkansas and Southern California, all of which verified the 65F base as being satisfactory. In some cases it was reported that degree day accumulations figured on the 65F base did not apply to all parts of the territory served by a particular gas company, but experience in the area has resulted in the necessary correction factors being developed. It is recognized that correction factors for parts of a given area may be necessary in many sections of the nation due to extremely high or low elevations and in sunny parts maximum and minimum temperatures may be affected markedly by solar radiation. However, from information received from these southwestern gas companies it is apparent the 65F base is satisfactory and one standard base for the nation is important to the objective of eliminating confusion. To establish varying bases for several parts of the country would have the opposite effect.

Standardization of methods, instruments and general procedure by the Weather Bureau is considered essential to establishing more reliable weather information over the nation as a whole. It is hoped that official degree day figures will also be made a part of the Weather Bureau service.

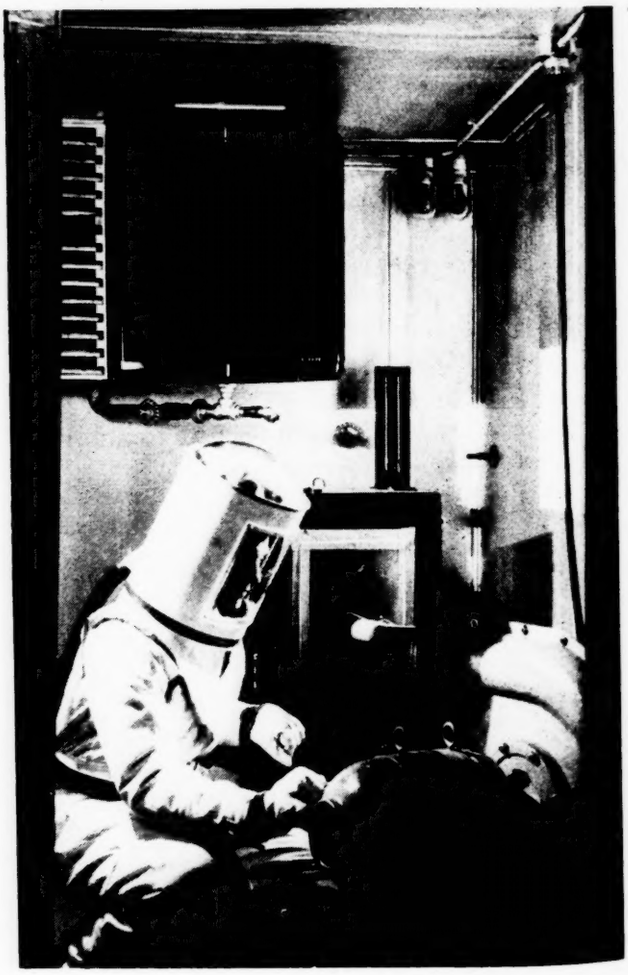
Unit Heater Used to Cool Plexiglas Test Room

Temperatures as low as —60F in the test rooms are no longer uncommon with elaborate air conditioning systems. Simple means of attaining subzero conditions are unusual.

Plexiglas, the transparent plastic used in the nose of several types of planes, and with a wide variety of other applications, is tested in the physics laboratory cold room of its manufacturer, the Rohm & Haas Company, Philadelphia, where temperatures ranging from —80F to 160F and with a relative humidity range from 10% to 85% are maintained.

The chamber is cooled by circulating an alcohol-dry ice mixture through a Modine unit heater. Heating is done electrically. Absence of frost and icicles on the instruments and equipment is explained by the low relative humidity in the room.

At high altitudes where temperatures of —80F are encountered, humidity is so low that no frost forms. Since Rohm & Haas are attempting accurately to simulate high altitude conditions, humidity is kept at a minimum. This is accomplished by circulating the air over trays of calcium chloride arranged in a rack which is visible at the left of the unit heater. All air in the room is recirculated by the unit heater.



Unit heater through which alcohol-dry ice mixture is circulated.

Air Processing Needs of Plywood Plane Parts

The accompanying study of air conditioning for a proposed plywood plane plant is presented because it shows the desirability of air control in a plant handling plywood, a material which seems to have a wide and expanding market, so that the data given by the author may have future value entirely aside from plane parts.

F. O. JORDAN
Mechanical Engineer, Albert Kahn Associated Architects and Engineers, Inc.

The manufacture of plywood airplanes involves mandatory precision control of air temperature and humidity so that exact tolerances can be established for the plywood parts. This is tersely brought out in studies made in connection with plans for a $2,000,000 plant to produce airplanes of bonded plywood. Although this plant has not progressed beyond the "paper stage", the findings are interesting and instructive.

IN the plywood process, the green wood or fresh-cut veneer sheets as received at the factory must be dried in a steam heated kiln or drier to a moisture content of 5 to 10% by weight. From this point on, the moisture content of the wood is controlled by holding the relative humidity of the air at the level at which the moisture content of the wood will come to an equilibrium between the prescribed limits. This humidity control of the air is maintained during the storage period and throughout manufacture until the airplane is completed. The moisture content of the wood, established by humidity control of the air in the plant, is maintained by a protective coating which seals off the wood from contact with the atmosphere.

Obviously, the great numbers of parts going to make up a modern airplane must fit perfectly when they are assembled into the final product. Since wood undergoes considerable dimensional change with even moderate variation in humidity, moisture is controlled to make possible assembly of a dependable product on a production basis. Without such control, there would be endless cutting and fitting of oversize parts and costly discarding of undersize ones will be unavoidable. Maintenance of a consistent production schedule would be inconceivable.

Curves published in the January, 1943, "Transactions of the A.S.M.E.", showing the relationship between the moisture content of Sitka spruce and compression strength, indicate the changes in strength with variations in moisture content as compared with the strength at 12% moisture content. See Table 1.

These data show an increase in strength with reduction in moisture content. However, if the moisture content is too low, the wood loses its ductility so that local concentrations of stresses may result in failure. Should moisture present be insufficient to supply the needs of the bonding material, starved joints may result.

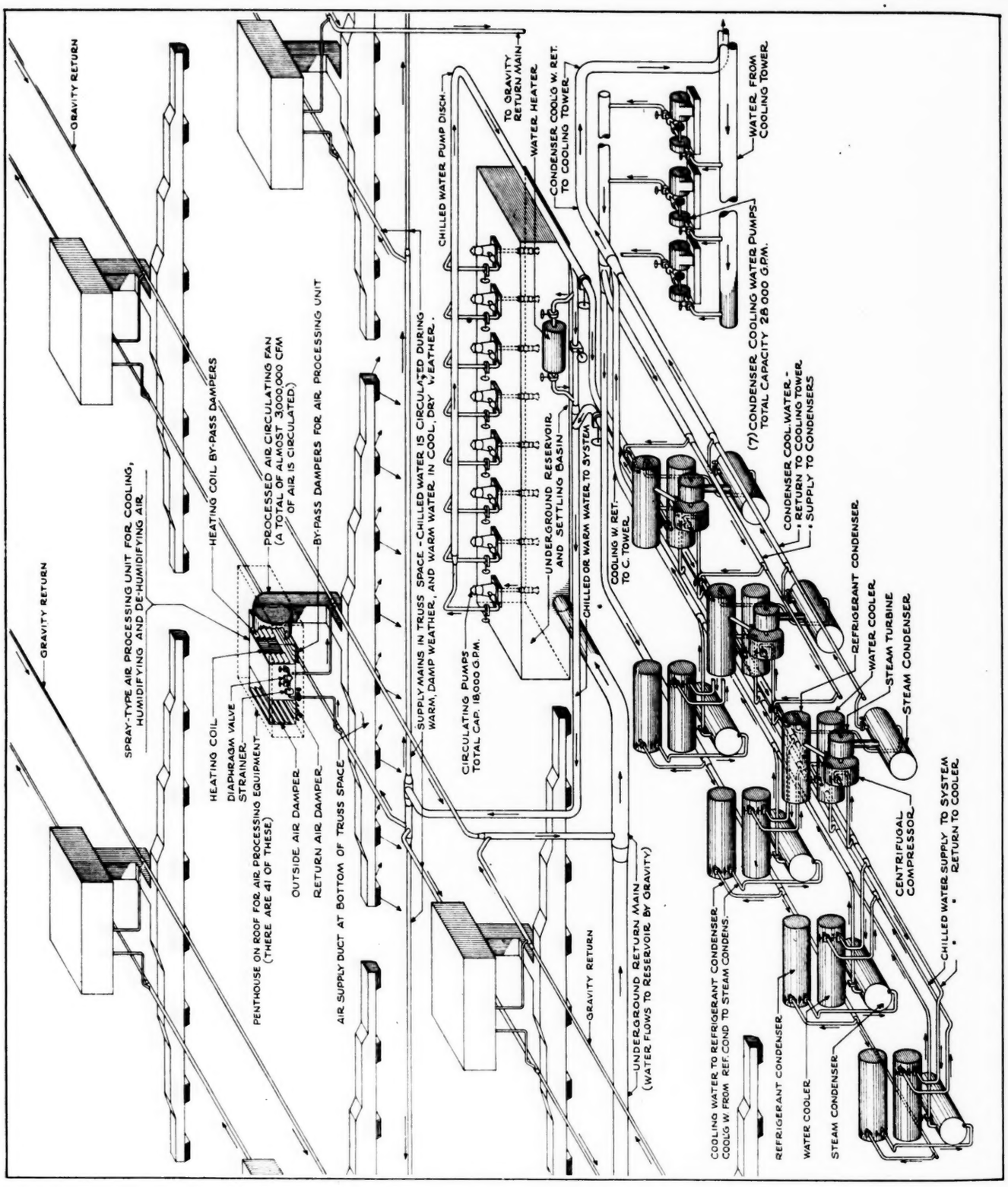
The customary moisture content limits are from 8 to 12% moisture with 10% as optimum.

Why this exact control? Veneers have been worked for a long time notably in the furniture industry, without closer humidity control than may be obtained by spilling a few buckets of water on the floor whenever the glue joints were starved by very dry air. However, joints in a writing desk are not subjected to large stresses nor to sudden weather changes common to the airplane. Nobody cares particularly whether all parts of a desk fit exactly or not.

While certain wooden airplanes were manufactured in this country and abroad without the benefit of humidity control, in many cases production schedules were loose enough to permit shutdowns of certain parts of the plant during humid weather. Some plants in Canada and England operate where climates are cool enough to allow the necessary reductions in relative humidity merely by heating the air.

TABLE 1—RELATION BETWEEN STRENGTH AND MOISTURE CONTENT.

Moisture Content (Percent by Weight)	Ratio of Strength to Strength at 12% Moisture Content
4	1.45
6	1.35
8	1.20
10	1.07
12	1.00
14	0.85
16	0.78
18	0.70


GRAVITY RETURN
GRAVITY RETURN
SPRAY-TYPE AIR PROCESSING UNIT FOR COOLING, HUMIDIFYING AND DE-HUMIDIFYING AIR
HEATING COIL BY-PASS DAMPERS
PROCESSED AIR CIRCULATING FAN (A TOTAL OF ALMOST 3,000,000 CFM OF AIR IS CIRCULATED)
BY-PASS DAMPERS FOR AIR PROCESSING UNIT
HEATING COIL
DIAPHRAGM VALVE
STRAINER
PENTHOUSE ON ROOF FOR AIR PROCESSING EQUIPMENT (THERE ARE 41 OF THESE)
OUTSIDE AIR DAMPER
RETURN AIR DAMPER
AIR SUPPLY DUCT AT BOTTOM OF TRUSS SPACE
SUPPLY MAINS IN TRUSS SPACE - CHILLED WATER IS CIRCULATED DURING WARM, DAMP WEATHER, AND WARM WATER IN COOL, DRY WEATHER.
CIRCULATING PUMPS TOTAL CAP. 18,000 G.P.M.
CHILLED WATER PUMP DISCH.
TO GRAVITY RETURN MAIN
WATER HEATER
CONDENSER COOLG W. RET. TO COOLING TOWER
WATER FROM COOLING TOWER
(7) CONDENSER COOLING WATER PUMPS TOTAL CAPACITY 28 000 G.P.M.
UNDERGROUND RESERVOIR AND SETTLING BASIN
CHILLED OR WARM WATER TO SYSTEM
COOLING W. RET. TO C. TOWER.
CONDENSER COOL WATER - RETURN TO COOLING TOWER. SUPPLY TO CONDENSERS
REFRIGERANT CONDENSER
WATER COOLER
STEAM TURBINE
STEAM CONDENSER
CENTRIFUGAL COMPRESSOR
CHILLED WATER SUPPLY TO SYSTEM RETURN TO COOLER
GRAVITY RETURN
UNDERGROUND RETURN MAIN (WATER FLOWS TO RESERVOIR BY GRAVITY)
COOLING WATER TO REFRIGERANT CONDENSER COOLG W FROM REF. COND TO STEAM CONDENS.
REFRIGERANT CONDENSER
WATER COOLER
STEAM CONDENSER

Schematic view of the piping and equipment of the air processing plant.

Resulting temperatures do not set urea resins too rapidly for production to continue, or become intolerable for the workers. But even here humidity control would promote speed and continuity of production, and results would be of uniform quality.

Control of dry bulb temperature seems to have little or no direct bearing on wood in storage, or in areas where phenol resins are used to make and form plywood skins. However, temperature must be controlled in manufacturing structural parts, and in the sub-assembly and assembly areas where urea cold setting bonding materials are employed. A minimum of 70F is required to avoid too long a drying time, while 75F seems about ideal. At 75F the setting time will not interfere with a good rate of production, nor is it so rapid that presetting occurs be-

fore parts are in place and pressure applied. A dry bulb temperature of 80F seems satisfactory and is more economical to obtain; 85F may be acceptable for small parts that can be placed quickly after the urea resin is applied. Roughly, a 30 seconds decrease in setting time may be expected for every degree rise in dry bulb temperature above 70F.

Information from the Forest Products Laboratory of the Department of Agriculture shows that wood reaches the optimum equilibrium moisture content of 10% when the dry bulb temperature is 80F at a relative humidity of about 57%. Therefore, a conservative relative humidity of 55% will insure good results. This establishes 80F dry bulb temperature and 55% relative humidity as a satisfactory operating condition.

A synopsis of operations involved in manufacturing plastic bonded plywood airplanes, together with recommended conditions and the reasons therefore, follows:

Veneer Storage

Materials—Cut and dried veneer sheets.

Moisture content—8 to 12%.

Reason—Obtain uniformity of moisture content to eliminate internal stresses and warping.

Air Condition—55% relative humidity to control moisture content of wood, with 80F dry bulb temperature to make working conditions tolerable.

Laying up and Molding Veneers

Materials—Veneer sheets and tego film.

Moisture Content—8 to 12%, but all parts must be held within 0.5% to maintain dimensional stability and to obtain effective bond. Optimum is 10% plus or minus 0.5%.

Air Condition—55% relative humidity to control moisture content of wood and to prevent premature adhesion of the tego film; 80F dry bulb temperature to make working conditions tolerable.

Making Laminated Structural Parts

Materials—Aircraft spruce and urea cold-set resin.

Moisture Content—8 to 12%, but all parts must be held within 0.5% for dimensional stability, prevention of internal stresses and warping, and obtaining effective bonding.

Air Condition—55% relative humidity to control moisture content of wood with 80F dry bulb temperature to prevent premature setting up of the urea resin before parts can be placed and pressure applied.

Where Parts and Skins are Assembled Together

Materials—Structural parts, molded plywood, and urea cold-set resin.

Moisture Content—8 to 12%, but all parts must be held closer to prevent stresses and buckling.

Air Condition—Same as for making laminated structural parts.

Throughout all operations, less hand tool and fitting work is required for, as relative humidity is confined within closer limits, there is an increase in dimensional stability.

Porosity and thickness govern the time required for the moisture content of a piece of wood to reach a state of equilibrium with the relative humidity of the environmental atmosphere. Thin pieces, like most parts used in airplane construction, come to equilibrium in a few hours. Therefore, one may assume that the moisture content of wood parts on a given day will correspond to the average relative humidity for the 24-hour period.

If a moisture content of 10% is standard, the need for air conditioning or processing in a locality may be determined by plotting average relative humidity versus average dry bulb temperature for each full day on a psychrometric chart and noting how many of them fall above the 55% relative humidity curve. On days when the dry bulb temperature is low enough, the necessary reduction in relative humidity may be obtained by heating the air. Dry bulb temperature and relative humidity are often so high that this method would require temperatures above the 80-85 degree level, where work is impossible because of the presetting of urea resin as explained previously. When such conditions are encountered, uninterrupted production of serviceable airplanes demands installation of all-year air processing including cooling, dehumidification, heating, humidification, cleaning and distribution, all under effective automatic control.

In the latter part of May, in a plant where it had been decided that dehumidification and cooling would be unnecessary, troubles began to develop due to high moisture content. An analysis showed that the average relative humidity on 165 days from May to October was above the level corresponding to the optimum 10% moisture content of wood. The average on 160 days was above 12%, the maximum allowable. Maintaining the moisture content at 10% by heating the air would have resulted in dry bulb temperatures above 80F on 125 days during this period and above 85F on 52 days, so that cooling and dehumidification was necessary on such days.

In the final analysis, the outside air introduced was set at almost 700,000 cfm, and the total air circulation at approximately 3,000,000 cfm. Almost 20,000 gpm are chilled by the refrigerating plant and circulated to the air processing systems throughout the manufacturing areas. A cooling tower with nearly 30,000 gpm will cool the condenser cooling water.

Three types of systems were considered:

System A—Direct expansion units with all equipment located in roof penthouses.

System B—Indirect cooling and dehumidifying units located on the roof with refrigerating plant located in the power house for cooling water to be circulated to the cooling and dehumidifying units.

System C—Combination system using chemical

drying apparatus for dehumidification and refrigeration equipment for sensible cooling.

When the cost of additional structural supports and housing were considered, the indirect system (System B) was found considerably lower in first and annual costs. Furthermore, there was a large saving in critical materials because non-metallic washers could be used for cooling and dehumidifying the air instead of the coils required by the direct expansion system. Less copper was required by the steam turbine driven centrifugal compressors than by the direct expansion units since they must be motor driven. Other advantages of the indirect system were the possibility of the all-year use of the air washers for summer dehumidification and winter humidification under constant dew point control, and that the fine wood flour in the air resulting from wood sanding operations doubtless would plug up the finned coils or surfaces required by the direct expansion system.

The system favored makes use of 42 air processing units located in penthouses on the roof, each consisting of fan, air washer or spray type air cooler, and dehumidifier and heater. A year around condition of 80F, dry bulb temperature, and 55% relative humidity is to be maintained by operating the air washers under dew point control with by-pass dampers and back heaters under thermostatic control. Processed air is distributed through ducts located in the truss space where there will be no interference with the traveling cranes that service the entire manufacturing area.

Water circulated to the air processing units through overhead piping will be cooled in weather when dehumidification is required and heated when humidification is required by means of steam surface type heaters. Cooling will be done by seven 1,150 tons condensing steam turbine driven centrifugal water cooling units located in the power house. The condenser cooling water is passed through the refrigerant and steam condensers in series, and circulated to the mechanical draft cooling tower. Equipment for preventing corrosion is to be installed in the chilled water and cooling tower water systems, both being open to the atmosphere.

This system will cool and dehumidify and heat and humidify as required to maintain 80F and 55% relative humidity, all under automatic control. During high humidity, when dry bulb temperature is low enough for the required reduction in relative humidity without heating the interior above 80F, the heating coils only will be operated.

This arrangement will effect a sharp saving in operating cost as the refrigeration plant will operate only when the humidity cannot be regulated by heating without raising the temperature too high.

Coal Research Progresses

Successful research into the problems of production and utilization of coal have pointed the way to larger and sustained demand, according to a survey of the 1943 accomplishments of coal technologists at various research institutions, and reported by Bituminous Coal Research, Inc.

In addition to the publicized work of the Bureau of Mines in investigating the hydrogenation of coal and the synthesis of liquid fuels, the possibility of using low-ash coals as a source of carbon electrodes is being studied. These electrodes, made in large quantity for the aluminum and other electrometallurgical industries, have customarily been formed of petroleum coke. Other subjects being investigated at Pittsburgh are the viscosity of coal ash slags; prevention of external corrosion of furnace wall tubes; combustion of solid fuels by cross feed, as in chain-grate stokers; carbonization of Western coals in an effort to increase coke supply for the area's metallurgical industry. The Seattle station of the Bureau of Mines published reports on phosphorus in coal, and on the coking properties of Washington coal. Nevada coals are being tested for washability and for use in a gas producer, and similar tests have been completed on a Southwestern Washington lignite.

Coking and combustion characteristics of Illinois coals are being studied by the Illinois State Geological Survey, which is perfecting a method of making briquets without binder.

The West Virginia School of Mines is studying mine ventilation and the effect of various coal dust-proofing materials upon domestic stokers.

Production of plastics, carbon black and dyes directly from coal are among the objectives of The Pennsylvania State College. Work has been continued on the Pennsylvania stoker which incorporates the principle of preoxidation, and on colloidal fuels. Also being investigated are methods of controlling fly ash, clinker formation in underfeed stokers, hold-fire controls, and ash removal and disposal. A study is being made of mine accidents.

Five problems are receiving attention at Carnegie Institute of Technology, despite a serious curtailment in staff. These are the mechanism of combustion of pulverized coal; reactivity of solid fuels; oxidization of coal to organic acids; the primary hydrogenation of coal; and coal carbonization.

Battelle Memorial Institute continues and in some cases has completed successful development of smokeless heaters, domestic ash-removing stokers, complete gasification of coal, dust-proofing, and firing with pulverized coal of radiant tubes and other furnaces used in the metallurgical industries. Fundamentals of overfire air jets, for elimination of smoke in boiler furnaces, were determined.

The Case of the Waterlogged Coil

By JOHN J. WOOLFENDEN

Engineering Staff, Smith, Hinchman & Grylls, Inc.,
Architects and Engineers, Detroit, Mich.

ABOUT thirty years or so ago, when vacuum pumps on heating system returns were the exception, rather than the rule, and Hartford loops were unheard of, check valves were commonly used on return connections to prevent the water from backing out of the boiler into the system.

Of course they did not prevent the holding back of the water in the system as required to build up the head necessary to balance the differential steam pressure, but they did prevent any sudden or continuous flow from the boiler into the system, provided that the check valves closed tight, which they often did not.

As check valves are still used occasionally, the following account of one which closed tight and yet, so to speak, was not tight, may be of interest.

The installation was of the two-pipe type with direct radiation and underground piping between the boiler plant and the office building, some 150 feet away. There were two other large buildings, adjacent to each other, and one of these had a partial basement in which the boilers and other apparatus were located.

The first floors of all buildings were at grade level and, save for a portion of the radiation located with the lowest part about 3 feet below grade, all radiation was above the first floor. There was a water heater in the boiler room. This heater consisted of a steel pipe coil in a steel tank, as the present day, prefabricated, storage type heater was then unknown. It was hung from the boiler room ceiling construction and the return was run overhead to the boilers, there dropping into the return header at the floor below.

After the system had been in operation for a short time, it was found that, at irregular intervals, the heater failed to function properly and showed all symptons of a waterlogged coil; this, regardless of the temperature of the water in the tank.

It is, of course, possible for a water heater to have a high condensation rate and develop a corresponding vacuum in the heating element, but it is not normal for such a piece of apparatus to display symptoms of a flooded coil when the water in the tank is hot.

An examination of the piping arrangement disclosed no unusual conditions or any lack of height above the water line sufficient to account for the behavior of the apparatus.

The check valve was opened up and examined. It was in apparently perfect condition and there was no indication of scale or any other foreign matter in the valve or in the 2-inch pipe adjacent to it.

Still the unsatisfactory operation persisted in its irregular occurrence. Each time, the check valve was examined and each time there was no indication of any unusual condition.

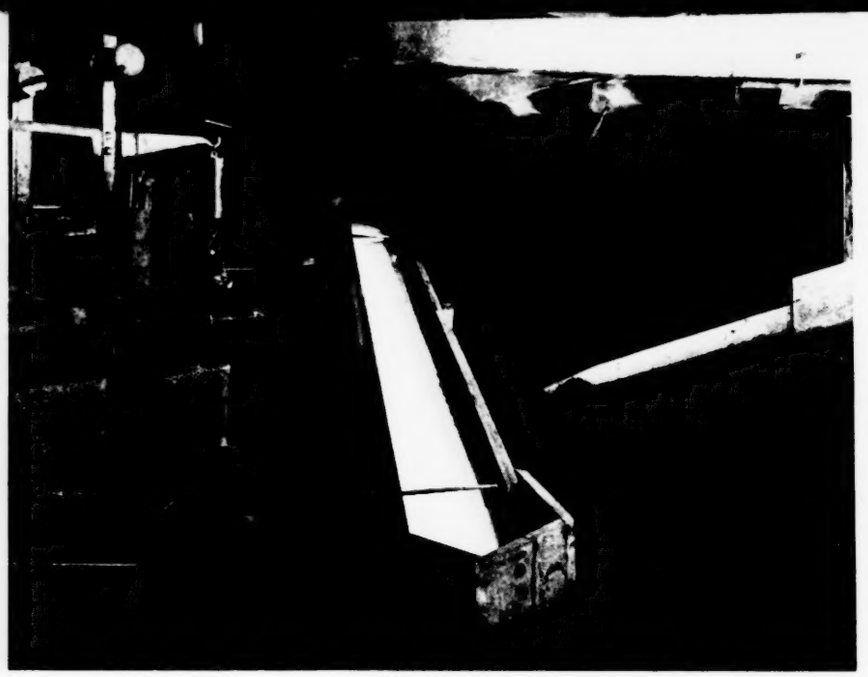
This sort of thing had been going on for about a week and the matter was getting serious, as the work was nearing completion and certainly could not be turned over to the owner in any such condition as was indicated by its failure to function properly.

As a last chance, the return and the steam valve in the heater connections at the headers were closed and the check again opened. As soon as the momentary rush of water subsided, the check was examined and apparently was in perfect condition, with no indication of the cause of the trouble.

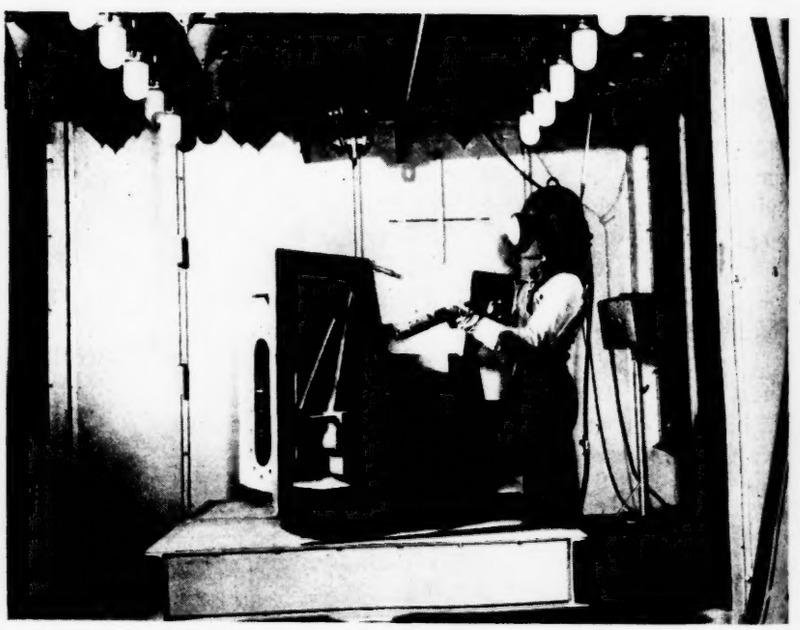
But wait! What was that? Just a fine thread, barely visible, caught under the tongue of the valve. The tongue was carefully raised and the thread very gently drawn; then more threads appeared and, finally, a small wad of waste, about the size of a walnut, came into view. This was removed, the cap screwed in place, the steam and return valves opened and the heater immediately started operating normally and continued to do so, thereafter.

The entire trouble was caused by this bit of waste at times becoming lodged under the tongue of the check. Any sudden flow, or surge, of water in the pipe, such as occurred when the cap was removed from the check, pushed it back, out of sight and reach. Had the one thread not have become caught under the tongue, as the check closed, the mystery might have remained unsolved indefinitely; at least until the piping, as a last resort, had been taken apart.

Picture



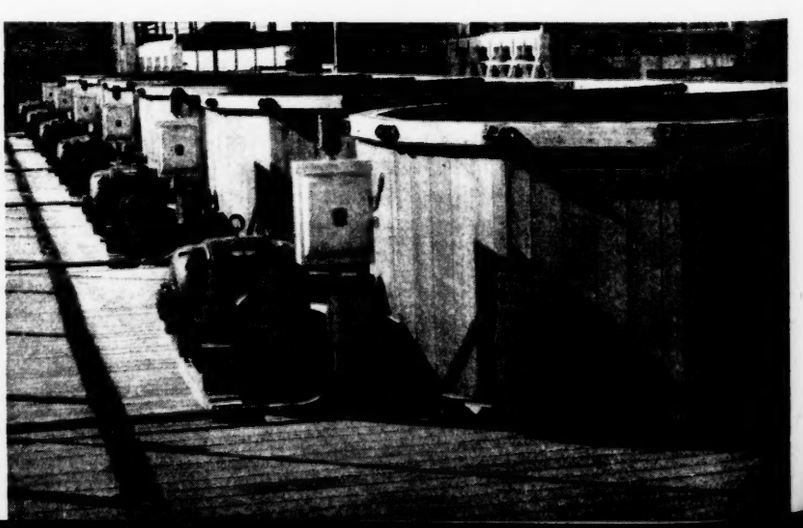
FIVE GLASS COAL CHUTES are at the Locust Coal Company breaker, Shenandoah, Pa. As a result of an experimental installation made of alternate sections of Carrara glass and steel, it was found that the steel plates had to be replaced every three months because of wear and chemical action of sulfur. The glass installation carries an average daily load of 100 tons, and has a long life. ←



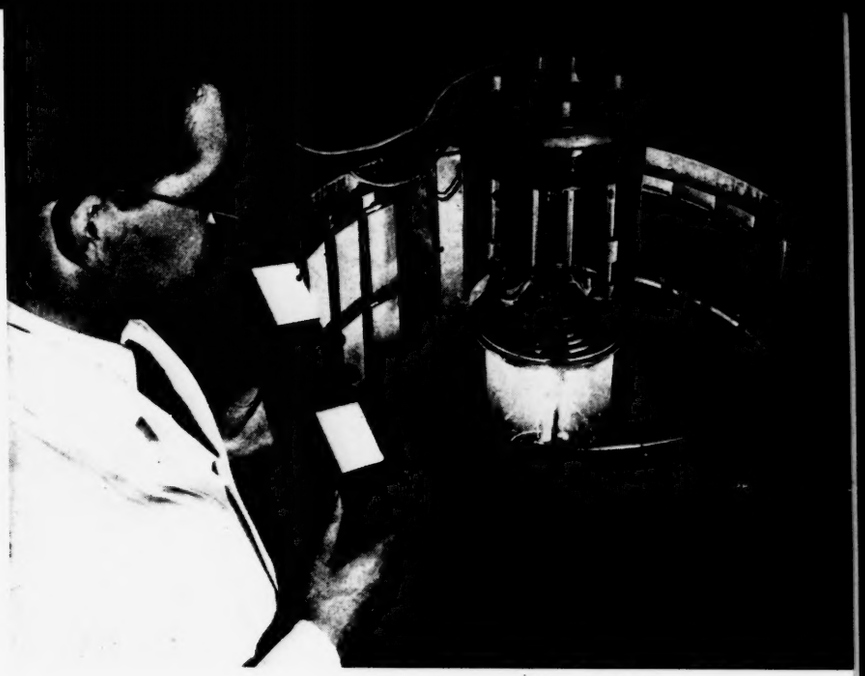
LARGE FABRICATED ASSEMBLIES such as this generator frame and turbine housing can be cleaned in a Parsons shot blast chamber. Dust and scale are carried out by the exhaust before it can settle with the shot that falls through the floor. Air enters chamber through ceiling vents and passes out through side wall outlets. →

A MOVIE CAMERA and a specially built condenser enable research workers at laboratories of York Corporation, York, Pa., to investigate the details of condensation. ←

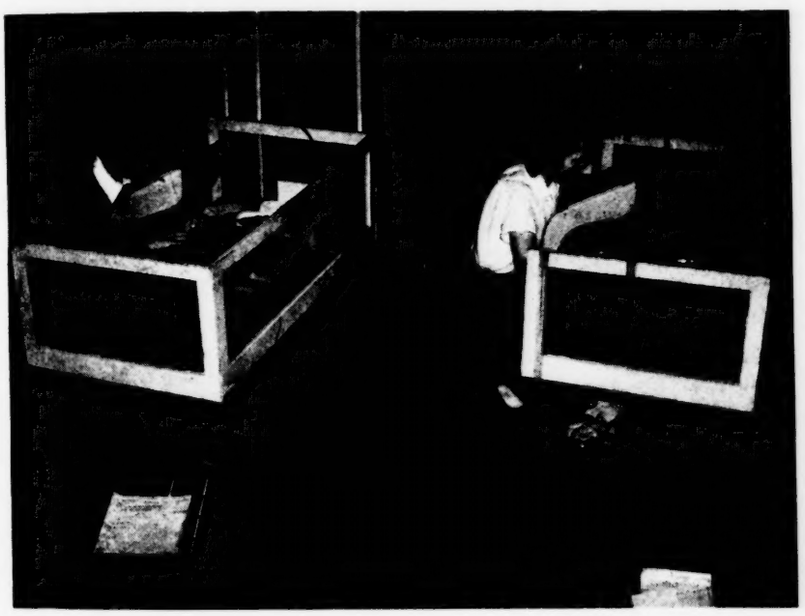
FLOOR COOLING TOWERS remove heat from circulating water used in turbo-blowers at Fontana, Calif., steel mill of Kaiser Company, Inc. Six-bladed plastic fans are driven by 30 hp Westinghouse induction motors.



Paragraphs



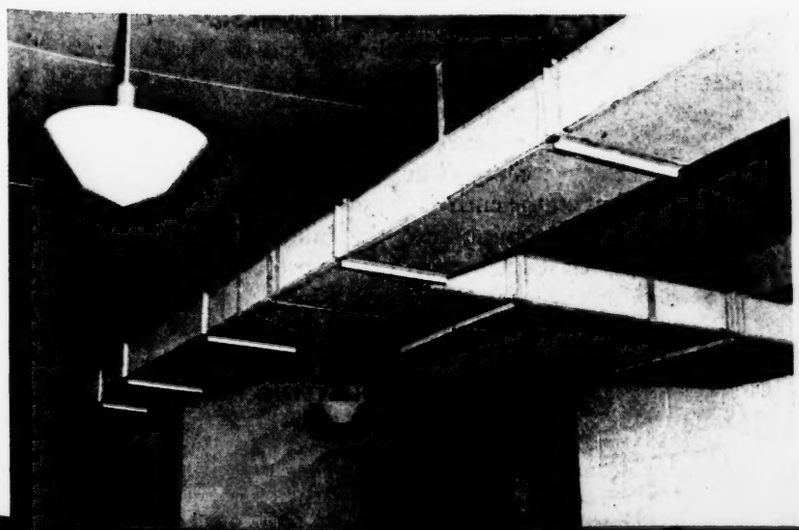
SYNTHETIC WEATHER CONDITIONS, 12 times as severe as those encountered in actual practice, are produced in the laboratory by this weather-ometer. A research laboratory maintained by plywood mills tests more than 150,000 samples yearly. A violet-ray lamp provides intensified sunlight. Exposure of a sample in this machine for a month is equal to one year's exposure to sunlight and rain. Photo by Douglas Fir Plywood Association. ⟶



GLASS SHIELDS protect women from dust and metal particles at the Cleveland Graphite Bronze Company, while buffing operators remove burrs from metal parts. Air is drawn into a duct behind the shield and is driven through filters behind the benches. Filter panels are easily ⟵ removed for cleaning.

PARACHUTES must be stored in conditioned air to increase their life and to make certain they will pack properly. Carrier equipment is used in this installation. ⟶

STRAP-HELD DUCTS in use at barracks occupied by civilian personnel at an Army air base. Steel corners and straps, made by Acme Steel Company, hold the processed sheets or boards.



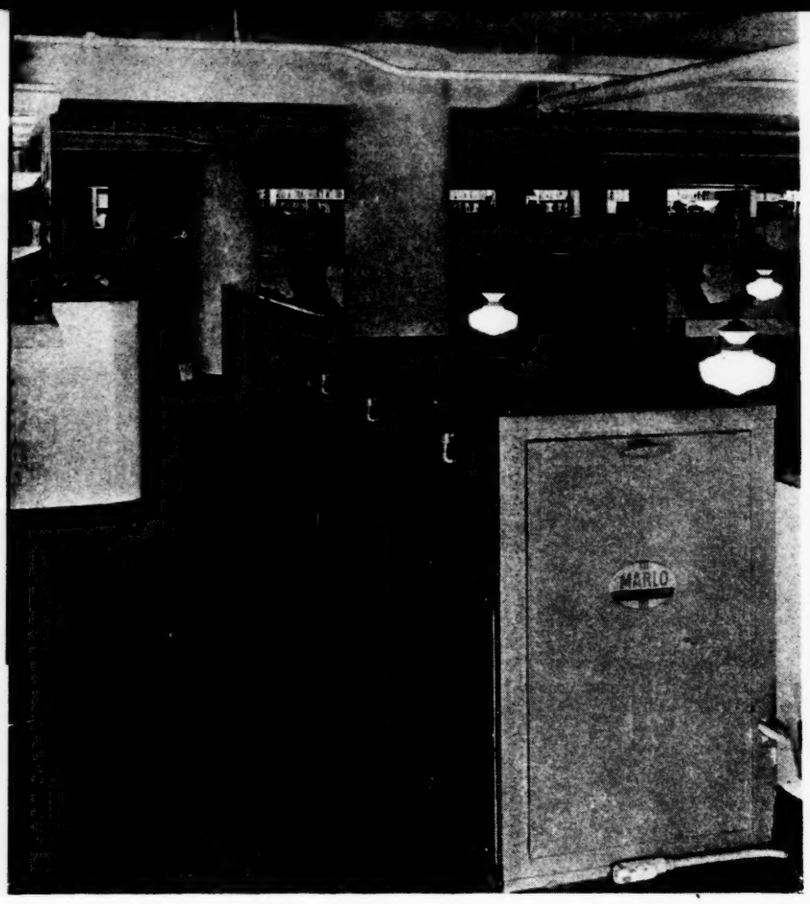


Fig. 1. Eight cooling and heating units of the type shown, located on the mezzanine, supply conditioned air throughout the year to the main floor. Chilled water provides the cooling effect in summer and steam is used for winter heating, both controlled by individual thermostats to give zone control.

Bomb Fire Smoke Guarded Against in Denver Store Air Conditioning System

AN air conditioning system which will (1) instantly shut itself off when smoke from incendiary bombs, or other fires, appears; (2) adjust itself to unusually large crowds; and (3) employ a choice of fuels, has recently been installed in the May Company department store, of Denver.

The new system, completed recently, covers a new five-floor annex building and the old building of the same size. The first floor is conditioned by a refrigeration plant in a new sub-basement, while the upper four floors will be equipped with an air-washer system supplying water-cooled air through ducts and outlet. The washer-cooler can, if desired, be converted quickly to refrigerative cooling when the end of the war makes available the necessary equipment.

A 50-ton reciprocating Westinghouse compressor is located in a new sub-basement under the new building, connected with a 400 gallon water chiller, circulating pumps, and a cooling tower on the roof, which replaced the evaporative condenser which could not be obtained. Cold water chilled in the chill tank is circulated by a single pump to eight Marlo coil cooling and heating units spaced around the first floor at the front of the mezzanine, 16 feet above the floor. Each of these units, all specially built for the job, contains a bank of coils which will utilize steam for winter heating and chilled water for cooling, and has a capacity of about 7 tons of refrigeration and a delivery of 6500 cfm. They are enclosed in a gun-metal box matching the rest of the mezzanine furnishings, with blower and coils entirely out of sight. Each unit is individually controlled to cool one of eight zones on the first floor, and can independently cool its area whether or not the other seven are operating. This eliminates the chilly spots of former department store systems and insures an even, economical temperature over the heavily-trafficked first floor. In winter, steam through the coils will likewise heat specific zones.

The upper floors are cooled by a single air washer using needle sprays in the washer housing, which also encloses a blower and filter. 108,000 cfm can be circulated, but half speed proved sufficient to cool both old and new buildings during the late summer. An outstanding feature is an automatic volume control on each floor which regulates the amount of water-cooled air which enters through the supply ducts. These ducts are 8 x 18 in. in size and average 14 in number per floor. The volume controls regulate dampers in the main ducts, so that when sales or special events cause unusually large crowds on any one floor, the amount of air delivered to that floor is increased accordingly. Latitude of the system is such that a volume of 50,000 cfm can be poured into a single floor or cut to 10,000 as desired. Control of the volume thus assures a steady 80 to 85F under all conditions.

Another novel feature is the use of photoelectric cell "watchdogs" in the ductwork to instantaneously shut off the entire system when smoke from any source begins coming into the building. These detectors consist of a beam of light projected down the main duct on each floor, which is sensitive to any smoke density of above-average amounts. Thus, should a

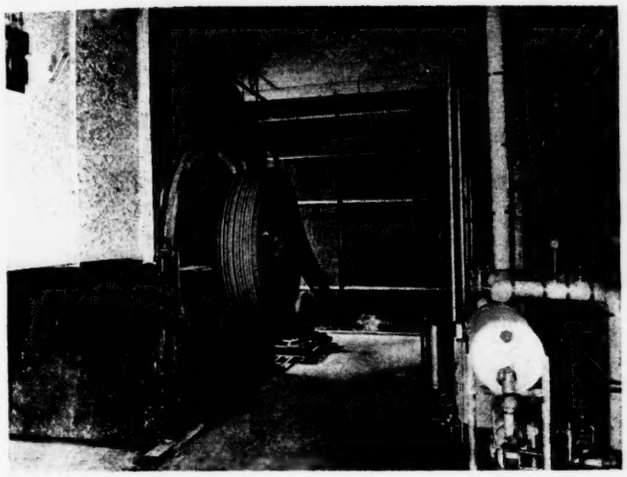


Fig. 2. A 108,000 cfm blower and spray washing unit circulate clean air at the correct temperature and humidity to the upper four floors.

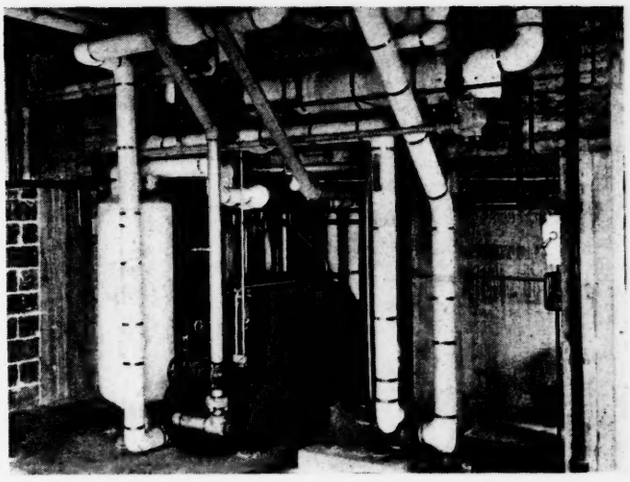


Fig. 3. Chilled water for the Marlo conditioning units on the mezzanine is furnished by this 50-ton Westinghouse compressor.

fire break out atop the building or in any nearby building, the first pull of smoke whirred into the air conditioning system will be detected, shutting off the blower, closing dampers and otherwise sealing it out. By this means expensive merchandise is thus protected against smoke damage and the possibility of panic and confusion among customers due to the presence of smoke greatly reduced. Stores have often been innocent sufferers in this way during nearby fires.

Winter heating will be provided on the top four floors by 30,000 square feet of steam radiation per floor connected to two low-pressure boilers — one burning oil, the other coal, and each ready to stand by in the event the other's fuel isn't available. Either boiler can handle the entire load, and economy is effected by burning up store waste in the coal-fired unit. Low-pressure steam will be circulated through the Marlo Coils on the first floor to heat this area.

The installation was made by Harry Herman, Westinghouse representative, Denver.

Skin Diseases Often Erroneously Attributed to Air Conditioning

The belief long held by operators of air conditioning equipment that chromate solutions used as anti-corrosion agents in spray water, and that refrigerants such as freon and carrene used in the compressor systems, frequently cause dermatitis has been only partially confirmed by studies conducted by Louis Schwartz, Medical Director, and John E. Dunn, P. A. Surgeon, U. S. Public Health Service, as reported in *Industrial Medicine* some time ago.

Chromate solutions thus used usually consist of mixtures of sodium chromate and sodium dichromate, in such strength as to give a concentration of 200 parts per million in the spray water. The salts are non-volatile in solution and any contact which workmen may have with them come from cleaning the spray chambers, from the act of adding additional salts, from leakage around pump packing, and from similar causes.

In the studies, 105 subjects in all were investigated. None of these investigations indicated freon or carrene as a cause of dermatitis among workers normally exposed to these substances in the usual air conditioning installation.

Of these 105 cases, 90 stated that they had more or less cutaneous exposure to chromates, and approximately 14% of the 90 claimed to have, or to have had, dermatitis attributed to this cause. Patch tests indicated, however, that probably not more than 5% had cutaneous hyper-sensitivity to chromates, indicating a cause other than chromates for the dermatitis.

The incidence of skin troubles of one type or another among the workmen examined was approximately 63%. Sixteen per cent showed dryness, fissuring, and thickening of the skin of the hands, which was thought to be caused by use of strong hand cleansers and solvents.

The majority of the skin diseases found were not of occupational origin. Fungus infections of the feet and dermatophytids of the hands were responsible for most of these, with a few cases of other non-occupational skin diseases making up the rest. The occupational skin diseases, including those caused by solvents and skin cleaners and those resulting from exposure to chromates, represented about 20% of all the skin diseases found.

Even though the percentage of dermatitis cases resulting from chromate exposure, as thus shown, is small compared with total cases from all causes, it is recommended that exposure to this solution be reduced to a minimum. All operators of air conditioning equipment should be impressed with the potential danger of exposure to chromates and should be required to use protective equipment whenever they have to work where chromate solution or precipitate is present.

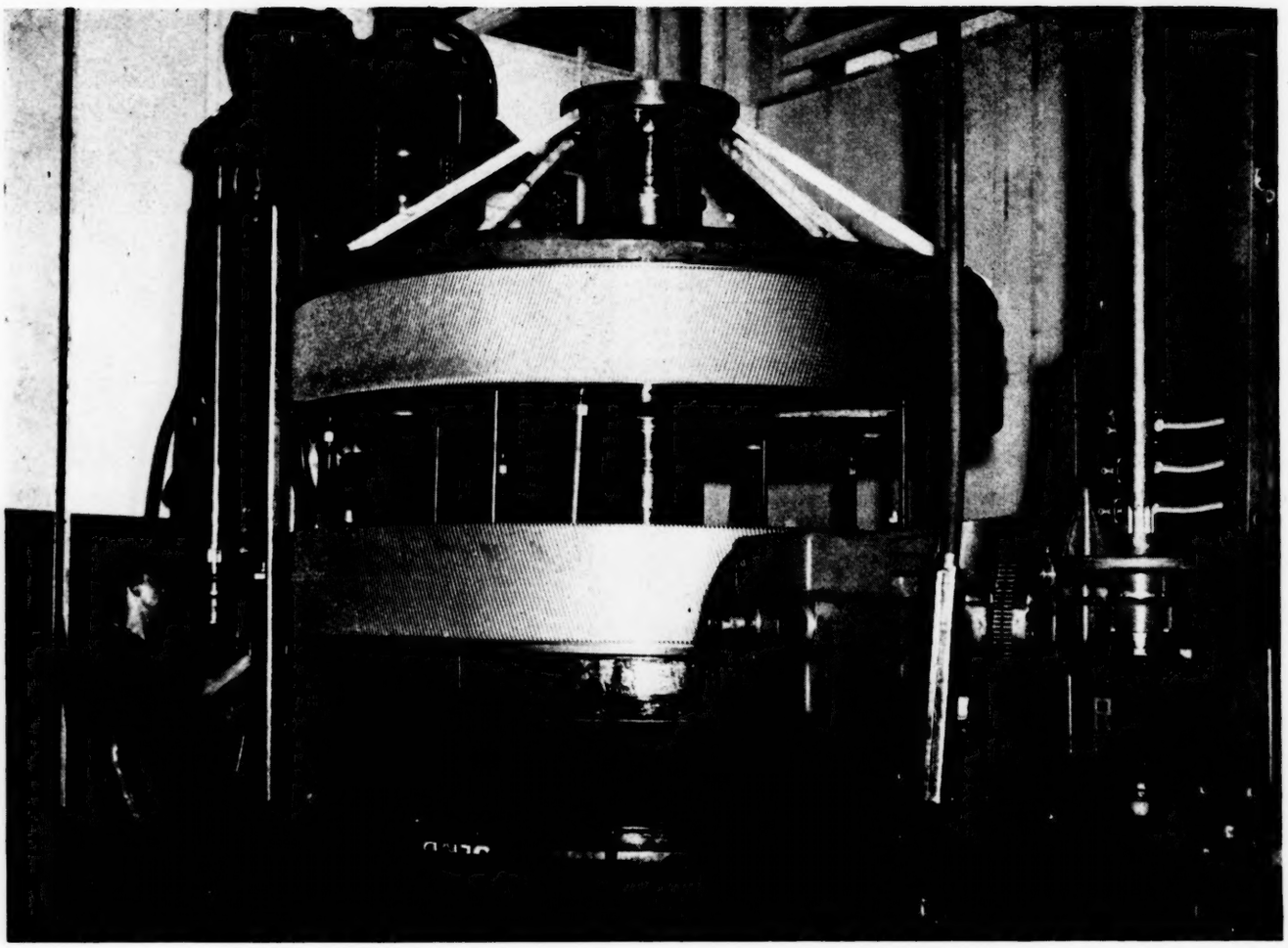


Fig. 1. These two big "bull gears" are cut with extreme accuracy in an air conditioned room on a double-cutter machine. It requires more than 300 hours to cut the teeth.

Maritime Commission

vessels have huge gears, hobbed in air conditioned rooms to insure accuracy; a 10F temperature change would cause a variation in the metal of .009 in., with unequal tooth loading.

M. KENNEDY
Merchant Marine Division
Westinghouse Electric & Mfg. Co.

A SECOND reduction or bull gear for an 8500 shaft-horsepower ship, the Maritime Commission's C-3 design, is 146 inches in diameter; its two helices are each eighteen and one-half inches wide and are separated approximately twenty-four inches. The extremities of the teeth are 60 in. apart.

To maintain tooth contact in a gear set of this proportion the shafts of the mating gear and pinion must be parallel, and the gear faces must be parallel to their respective shafts. If there are inaccuracies in the parallelism of the shafts or faces, or in the teeth, the load on the teeth will be unequally distributed; some teeth or portions of them will mesh lightly, or not at all, and others will be loaded in excess of their designed capacity.

Obviously, the tools used in the manufacture of marine gear units must be the most accurate obtainable. This is particularly true of the lathes on which the gear blanks are turned, the boring mills which bore the housing fits for the bearings and the gear

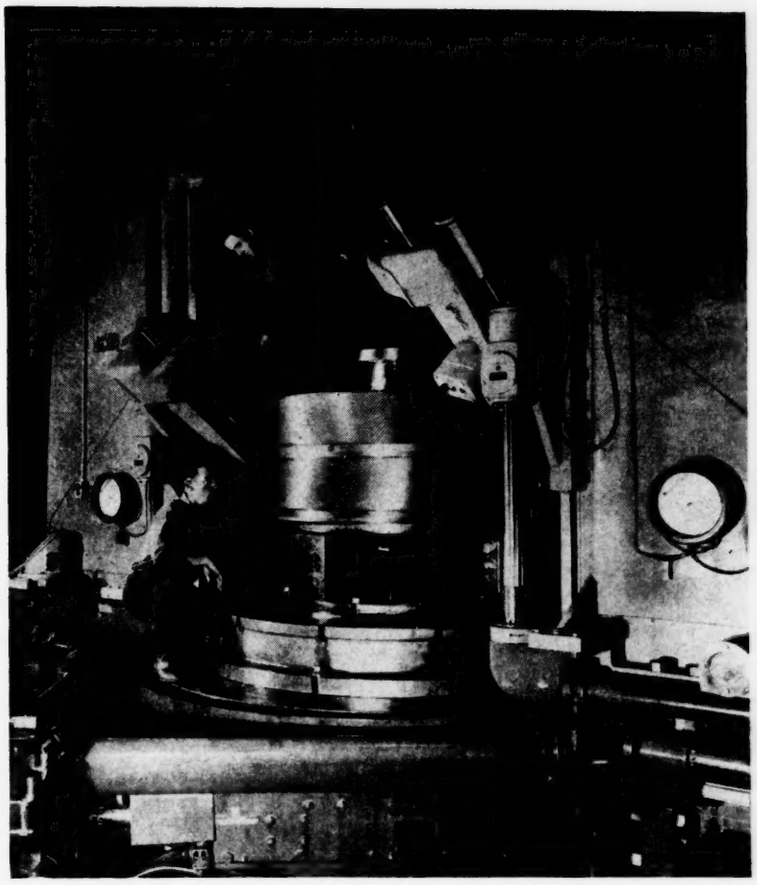


Fig. 2. Marine reduction gears are cut with the greatest precision in air conditioned rooms at several plants of the Westinghouse Electric and Manufacturing Company. Once the tooth-cutting operation is started, it may continue without stopping for seven days at constant temperature to insure the utmost accuracy.

hobbers which generate the teeth. Of these three tools, the gear hobbers offer the greatest problem because of the complex design.

The hobbers themselves are marvels of accuracy. The 60 in. vertical slides for the hob carriers are so carefully hand scraped that the hob does not vary 0.0002 in. to or from the table throughout the entire face of the gear to be hobbed. Even the perfection of the machine is not sufficient safeguard for accuracy as a 146 in. gear will expand 0.009 in. in diameter with a temperature change of only 10F. If the hobbing operation started at a temperature of 70F and finished at 90F, the hob would be .009 in. deeper in the gear at the end of the cut than at the start.

Air conditioning of a huge shop is within the range of possibility, but hardly justified when most operations are not affected by temperature variations.

Consequently, the temperature of the gear hobbers and the gears must be controlled if accuracy is to be obtained. Compensation, as provided for in a clock, can be used only in a simple mechanism. In a gear hobber the large number of complex parts eliminates the possibility of compensation.

At the Westinghouse Merchant Marine plant, each of the hobbing machines is enclosed in an air conditioned room and the temperature is maintained between 68 and 70F. The temperature of the gear being cut rises above room temperature as the first few cutting revolutions progress. This generated heat is partly carried away by an oil flush and partly distributed through the gear so that the temperature remains constant throughout the cut, even though above the room temperature.

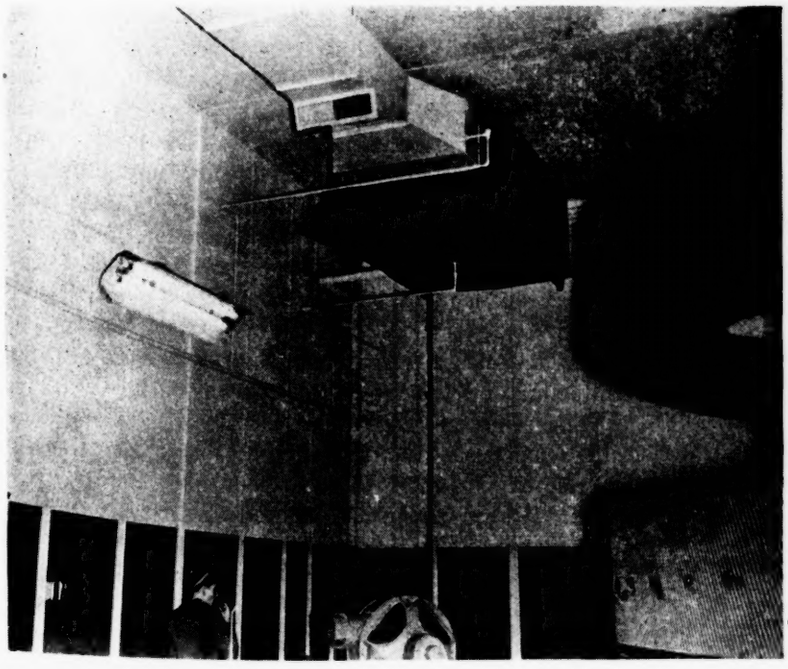


Fig. 3. Five-ton Westinghouse air-conditioning unit maintains room temperature between 68 and 70F during gear hobbing operation. Here a 146 in. marine gear is being hobbed at the Westinghouse Merchant Marine Plant.

Portions of the hobber, particularly where the moving parts are carried in bearings, change temperature with operation. As in the case of the gear, these parts reach and maintain constant temperature while teeth are being generated in a gear.

The finishing cut is the critical period in cutting a gear. One hundred and twenty-five hours of continuous operation is required for the finish cut on a bull gear helix having 693 teeth, a hob diametral pitch of 5 and an 18½ inch face. If the machine stops during that period, the gear may be ruined. When the hobber stops cutting, the gear changes temperature, gradually cooling and contracting until room temperature is reached. In some cases it is possible to save such a gear by withdrawing the hob and starting the cut at its beginning. The salvage of such a gear depends upon how close to tolerance the original cut was running.

While the prime purpose of the air conditioned rooms surrounding the hobbers is to maintain constant temperature, it is also advantageous in maintaining constant humidity. With wide fluctuations in temperature and humidity that are encountered in the Philadelphia area, condensation can cause considerable corrosion of finished surfaces. A gear, cooled by low temperatures of a Spring or Fall evening can become dripping wet during a succeeding hot humid day. A completed gear is slushed to avoid damage from this source. During the hobbing operation, if carried on in the open, it would be possible for corrosion to occur on one helix while the other was being cut.

Lead-Coated Steel Sheets for Sheet Metal Work

FURTHER usefulness of lead as a corrosion resistant coating on iron and steel is indicated by the development and improvement of hot-dip lead-coated steel sheets. Although certain experimental work done in the past indicated that good results might be obtained with lead on sheets, the general acceptance and use of long ternes and galvanized sheets deterred the final development as well as a marketing campaign which would have brought about a general use. Also the tendency of lead-coated steel samples to develop rust stains on the surface gave the impression that the coating did not cover completely and so would not give adequate protection.

An installation of Lead-Sealed sheet metal ducts in a heating system. Photo by Continental Steel Corporation.

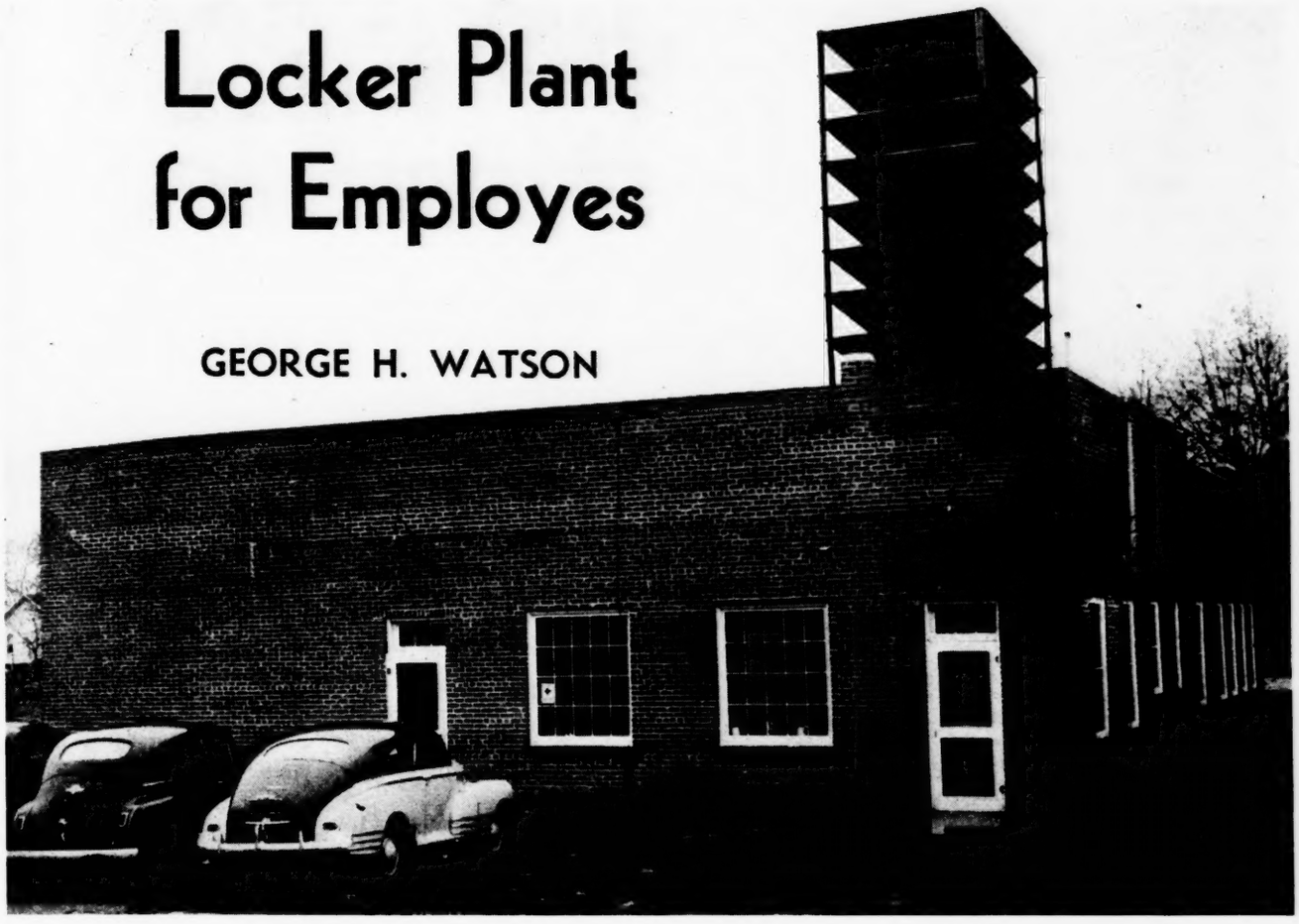
More recent research and reference to some almost forgotten test samples still under exposure have shown that lead-coated ferrous sheets are remarkably durable and that they stand up well in severely corrosive atmospheres. The surface rust stains which were once thought to be signs of incipient breakdown have been found to be merely superficial. They disappear very soon when the microscopic pin holes which allowed them to form are filled and stopped by the products of oxidation.

In addition to their durability lead-coated sheets possess several other desirable characteristics. They take and hold paint well. They may be painted immediately upon fabrication without aging or other special preparation. The lead alloy coating is ductile and withstands bending and forming without showing a tendency to crack and flake off. Lead-coated sheets can be die formed, the lead coating actually helping the process by acting as a lubricant to the dies. Since lead coatings are applied at comparatively low temperatures, there is little tendency for the characteristics of the steel sheet to change under influence of the heat of the coating bath.

The renewed interest in lead coating of iron and steel sheets is due in part to shortages of other metals which have normally been used for this purpose. However, the lead-coated sheets have advantages which will cause their use to be extended after the war emergency has passed.—*Abstracted from "Lead," a publication of the Lead Industries Association.*

Locker Plant for Employes

GEORGE H. WATSON



SEVERAL interesting features are included in a new food processing and locker plant completed at Alexander City, Ala., by Russell Mills, cotton textile manufacturers. Although designed as a 500-locker plant, 400 lockers are now installed.

Russell Mills is believed to be the first industry to erect a locker plant, principally for its employes, to encourage them to raise their own meat. The plant is not only complete in regard to equipment for the chill room, processing room, quick freeze room, and locker storage, but also provides modern facilities for handling pork products including a curing room, a smokehouse, and a smoke meat storage department. Plans have been made to install a dehydrating plant and a poultry processing department.

There are devices for automatic control of temperature and humidity of the various rooms, and for keeping the air fresh and free of objectionable odors.

The layout makes possible straight line production methods. Pork and meat carcasses move on an overhead track from the slaughter pen to the chill and aging room, then to the processing room. Here the meat is cut up. Chops and steaks, if desired by the customer, are quick frozen for later storage in the lockers. Pork products such as hams and shoulders are put in line for the curing room, the smokehouse, and then the smoke meat storage room.

All refrigerated rooms are insulated with 4 to 9 in. of cork, finished on the inside with Korkseal and painted with a special aluminum paint.

The 16.2 x 45.5 ft locker room has all-steel lockers and is served by overhead coils, fully flooded and equipped for hot blast defrosting. Ammonia in these coils is automatically controlled by a thermostat and solenoid valve to maintain an average temperature of —5F. Coils in the quick freezer are of the shelf type, mostly located at the top, and are connected to the same accumulator as the locker storage coils. The thermostatic control in the quick freezer is arranged so that the refrigerating machine will not stop until the room has a temperature of at least —18F.

Warm Air for Defrosting

The quick freeze room is also equipped with a blower of the squirrel cage type, so that warm air may be circulated over the coils during defrosting, which is accomplished by a hot ammonia blast. A change of air is also obtained at the same time, eliminating any foul odors.

The 12 by 36 ft chill and aging room is arranged with three sets of overhead rails and with track doors at both ends, so that carcasses after the curing period may be moved into the processing room without backtracking. Temperatures of 32 to 34F are

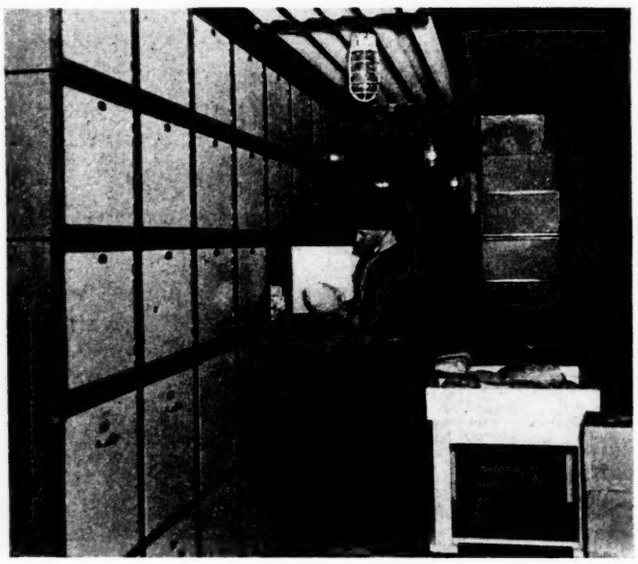
maintained by two unit type coolers. Temperature control is by means of a thermostat operating a solenoid valve in conjunction with a thermo expansion valve. The room is equipped with hand operated dampers to control ventilation.

The 10 x 36 ft salt meat curing room is arranged with rows of meat bins on either side of a three-foot walkway. Cooling is provided by 2 unit type coolers with a fan capacity to give approximately 30 feet per minute air circulation. There is also the same arrangement of solenoid and back pressure valves to control humidity and temperature, and an electric clock defrosting device. A temperature of 36-38F is maintained.

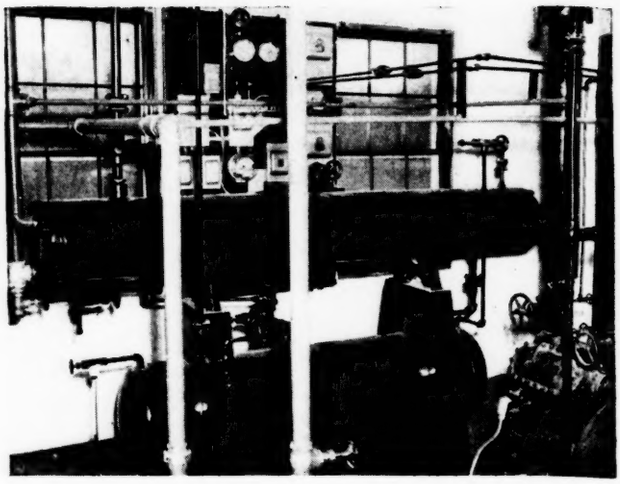
After the pork is cured it is removed to the smokehouse, 14 ft square, equipped with a Dutch oven type fire box, located outside the smokehouse. Smoke is brought through a tunnel under the floor and distributed throughout the room. At each corner is a smoke outlet to the roof with an adjustable damper to regulate smoke density. Thermostatically controlled steam coils extend around three sides of the smokehouse.

Steam is furnished from a stoker-fed steam boiler, located in a boiler room next to the smokehouse. The boiler room is also equipped with a hot water tank which supplies adequate hot water for cleaning, scalding and washing. A gas fired lard rendering kettle, operated in connection with the slaughtering department, is controlled, so different size batches of lard may be handled.

Equipment in the machine room includes a York 4-cylinder, 7-ton, V-type compressor, arranged with an unloading device, so that its capacity will be reduced in case one or more of the storage rooms are satisfied as to temperature requirements. The ammonia condenser is of the multi-pass, shell and tube type, and of larger capacity than usually installed for this load.



Individual storage spaces in the locker room. Lights are protected by vapor-proof globes.



Engine room of the plant showing the compressor.

The cooling tower on the roof is of the atmospheric, apron louvre type and of a capacity to cool the water to within a few degrees of the wet bulb temperature. The centrifugal water pump is arranged to start when temperature in any one of the refrigerated rooms rises above a fixed point. The ammonia compressor is operated from the electric starter on this pump.

The plant is equipped with such safety devices as relief valves, high pressure cut outs, and thermo relays.

The plant is housed in a brick building, 55 by 67 feet in size, specially built. A small lobby is adjacent to the processing room. All lights in refrigerated rooms are of the vapor-proof type.

Stiles O. Lokey, Birmingham, Ala., was the consulting engineer, and Rushton Equipment Co., Birmingham, York representatives, installed the refrigeration equipment.

Equipment Suppliers

Compressor—York Ice Machine Co.
Lockers—All Steel Equipment Co.
Storage doors—Jamison Cold Storage Co., Hagerstown, Md.
Korkseal—Lewis Asphalt Engineering Co., New York
Thermo valves and solenoids—Spoehrer-Lange Co., St. Louis
Unit coolers—Rempe Co., Chicago
Back pressure valves—Refrigeration Specialty Co., Chicago
Water Pumps—Gould Pumps, Inc., Seneca, N. Y.

Contractors and Engineers

Consulting engineer—Stiles O. Lokey, Birmingham, Ala.
Refrigeration engineers—Rushton Equipment Co., Birmingham
General Contractor—Bledsoe Davis, Alexander City, Ala.

WASHINGTON NEWS

Summarized by Loring F. Overman; Heat Exchanger Order Is Modified; Condensing Unit Bases Now Allowed; Freon Shortage Curtails Railroad A. C.

That the wearer of brass hats and gold braid will continue to hold the aces in the production control game, at least until favorable scores begin to roll in from the invasion beaches, was indicated again during March whenever the subject of reconversion was discussed by representatives of heating, ventilating and air conditioning industries. Notable examples were the following:

(1) Army and Navy talked the War Production Board out of the idea of permitting manufacture of limited numbers of Class B (domestic) stokers, contending it would take too many small motors and scarce electrical controls;

(2) Recommendation of the oil burner industry advisory committee that it be permitted limited production of domestic type oil burners is still "under consideration" by WPB. It may be assumed that rejection of the stoker construction plan will serve as a guide in the case of domestic oil burners; and

(3) Brigadier General C. D. Young, acting director of the Office of Defense Transportation, announced March 21 that railroad air conditioning will be curtailed this summer, due to the heavy demand for Freon for mosquito-fighting overseas.

Although the month did bring some relaxation in the use of metals in heating, air conditioning and refrigerating units, none were for the purpose of expanding production. All were in line with the program, as summarized in this column last month, of resubstituting available metals for substitutes that have proved less satisfactory, or have required a greater amount of manhours to fabricate.

Added to the list of relaxed orders during the month—65 "L" and "M" orders are undergoing an overhauling to permit a return to more normal manufacturing methods—were the following:

L-42, Heating Simplification

Schedule V of Order L-42, the general plumbing and heating simplification order, was amended March 15 to permit production of extra heavy cast iron soil pipe for maintenance and repair purposes. Production of the heavy type pipe, prohibited since June 1, 1942, will permit the use of large quantities of heavy fittings now in inventories. The Victory weight pipe was not satisfactory when used with extra heavy fittings.

Another reason for permitting production of extra heavy pipe was the fact that plumbing codes of numerous municipalities require extra heavy pipe, and since no additional manpower or facilities will be required to produce the pipe, it was decided to permit resumption of production.

Although additional cast iron will be required, present supplies are sufficient, according to WPB. It is not expected, however, that the demand will be great, since new construction is limited and the extra heavy pipe will be used mainly for maintenance and repair purposes.

L-107, Extended Surface

Schedule I to Limitation Order L-107 (Extended Surface Heating Equipment), has been amended to effect the following changes:

(1) In larger housed blower units of standard size unit heaters, it is now possible to substitute a tube-within-a-tube heat transfer element of *no greater* heating capacity than that replaced. Formerly only a tube-within-a-tube heat transfer element of the *same heating capacity* as the one replaced could be substituted. This change was made because it was intended to restrict the use of larger elements and not to limit the manufacturer to one particular size;

(2) Manufacture, fabrication or assembly of convectors by any producer is limited to not more than 20 sizes of heat transfer elements in each of the permissible depths (6, 8 or 12 inches). Previously the producer was limited to not more than 20 sizes as determined by the rated EDR capacity. This change will permit manufacturers to make units of different measurements provided they do not involve more than 20 sizes in each depth, and

(3) Recessed or semi-recessed cabinets for convectors for use in hospitals for mentally disturbed patients may now be produced. Formerly, only wall and free-standing cabinets were permitted.

L-123, Industrial Machinery

A new minimum preference rating of AA-5 or better, designed to curtail distribution, has been established for 22 classes of industrial equipment. The classes of industrial equipment affected by the change in rating requirements, now covered by this amendment to Limitation Order L-123, include air filters, arc welding machines, flexible metallic hose, tubing and fittings, oil filtering and re-refining machines, certain types of industrial ovens, and pressure vessels.

The order also covers some additional sizes and kinds of compressors formerly under Limitation Order L-100; high pressure blowers formerly under Limitation Order L-163; heat exchangers formerly under Limitation Order L-172; pumps formerly under Limitation Order L-246; and fans and blowers formerly under Limitation Order L-280. A number of these kinds of equipment are also subject to General Scheduling Order M-293.

L-126, Industrial Refrigeration

Specifications for refrigeration condensing units for industrial and commercial refrigeration and air conditioning machinery and equipment were removed, on March 10, by WPB revocation of Schedule II to Limitation Order L-126 (Industrial and Commercial Refrigeration and Air Conditioning Machinery and Equipment).

An important feature of the action was the removal of the prohibition on the use of steel in the construction of bases for refrigeration condensing units having motors over 20 hp in size. Revocation of this restriction will save valuable manhours formerly required to erect concrete bases at the time of installation of the unit. The original purpose was to conserve steel, but now that the type of steel required is generally more available, it is considered more important to conserve manpower.

Revocation of the schedule also removed standardization restrictions which limited the number of models that each manufacturer could produce. Since a large percentage of the units now being produced are for the Army, Navy and Maritime Commission, and since those produced for these agencies were exempted from the model standardization, it was felt by WPB that these

restrictions were no longer necessary.

Metallic Bellows

Problems presented in meeting production requirements were reviewed at a metallic bellows production conference called in Washington recently. Metallic bellows are vital sub-components in such mechanisms as panel instruments and oxygen regulators aboard aircraft, and in industrial instruments such as temperature and pressure measuring devices. The conference discussed the areas having the most difficult production problems and possible procedures for relieving these situations.

It developed that a number of producers manufacture metallic bellows only for in-plant consumption. This production involves a limited number of simple types required for their major assemblies. In most instances, this capacity is only sufficient to meet producers' own requirements, manufacturers at the conference said. Where additional capacity exists, they said, the manufacturers are not able to produce the type bellows used commercially, due to engineering technique, machinery, or qualified labor required for their production.

Manufacturers producing metallic bellows for commercial distribution suggested that their production be scheduled under Order M-293 (General Scheduling Order) so as to establish the realistic manufacturing time to be considered in procurement, and that this information be made available to claimant and procurement agencies. They also suggested that an industry advisory committee be organized to consult with the Industrial Instrument Branch of the Radio and Radar Division, WPB, on future problems.

Industry members at the conference agreed that considerable progress already had been made toward relieving the production situation. The principal producer of metallic bellows reported production in 1943 was three times that of the previous year and that 1944 prospects were favorable for further increased production. Despite this favorable factor, the expanding requirements for this sub-component continue to increase the total backlog.

Heating Controls Studied

The Office of Civilian Requirements has under consideration a program which, if proposed allocations of metal are granted, would materially increase the manufacture of heating controls for civilian use. The initial program included allocations for 600,000 units, and it is understood that the new proposal would approximately double this number.

An unofficial committee composed of 40 manufacturers of heating controls was scheduled to gather in Washington March 30 to urge that heating controls be given greater consideration in the 1944-45 fuel conservation program of the War Production Board. Past programs have stressed the importance of insulation and storm sash, but with controls likely to become available in increasing quantities, manufacturers are given an opening to urge that fuel savings possible through heating controls be publicized.

WPB Urges Planning

Anticipating the time, just a few months hence, when refrigeration equipment will be operating at its peak, the War Production Board has issued a comprehensive statement urging pre-summer planning by equipment users and service organizations.

Refrigeration service shops should prepare now for the heavy demand for their services that is expected to develop this summer, the War Production Board stated March 22. To render the best possible service during their peak demand period, it is necessary that these shops have sufficient materials and parts on hand or available in a supplier's warehouse, WPB said. They must also have adequate labor and transportation.

Orders should be placed now for future delivery of parts and materials which repair shop operators know will be required in their service business this summer.

A procedure has been established for obtaining parts requiring ratings and materials requiring an allotment symbol, WPB explained. Controlled Materials Plan Regulation 9-A provides a method for repair shops to obtain parts and materials for domestic refrigeration repair services. Order P-126 makes provisions for repair shops to obtain necessary parts and materials for commercial and industrial refrigeration repair services.

Untimely Pipeline Squabble

With OPA nearly ready to announce its fuel rationing plans for next year, with coal production totals still dropping below levels needed to build up a reserve for next season, and with volunteer save-more-fuel committees being organized in many communities, it seems rather incongruous to find a squabble on between proponents and opponents of the Big Inch, the Little Big Inch, and other pipelines.

Sparking the argument was the Adoue-Finney report of pipeline activities, submitted at a recent meeting of the American Institute of Mining Engineers. The report indicated that the cost of shipping oil through the Big Inch is approximately 10.4 cents per barrel, and forecast that the pipelines would be major competitors of tankers after the war.

Opposing this view, James A. Moffett, former executive vice president of the Standard Oil of New Jersey, took to the public prints with an estimate of 54 cents per barrel, and a statement that the Big Inch and Little Big Inch "are a wanton waste of steel, a wanton waste of taxpayers' money, and will have no value except to be scrapped after the war."

Freon Up, but Down

Freon production during March was expected to be upped by 600,000 pounds by the opening of the Kinetic Chemical Company's expanded plant at Deepwater, N. J., but WPB officials report the increase merely a start toward what is really needed. It was expected that total Kinetic production for March would total 2,500,000 pounds, and that production when peak capacity is reached during April will be nearly 2,900,000 pounds per month.

Although WPB planned to use the extra 600,000 pounds to replenish depleted warehouse stocks, indications were that only the most essential uses would be permitted to make withdrawals. Washington newspapermen have rather belatedly sensed the meaning of the Freon shortage and are warning Congress and Government employees that hot days are ahead if anything happens to present supplies of refrigerant in comfort air-conditioning plants.

Recalling how jealously Congress has guarded its air-conditioning equipment (Bills intended to authorize transfer of government-owned equipment to war plants have invariably died in committee) the air conditioning industry may get some noisy official publicity in the Federal Register this summer if any of District's big plants are inoperative.

That one of the first official actions of the acting director of the Office of Defense Transportation was to announce the curtailment of air conditioning for railroads, is also significant of the seriousness of the Freon situation. The ODT Acting Director, Brigadier General C. D. Young, commented: "The War Production Board has limited the present use of Freon to sealed cars. In sealed cars the windows are permanently fixed and cannot be opened. Sealed cars account for 4,600 of the 8,000 mechanically air-conditioned railroad cars. Appeals may be made to the WPB for Freon for use in unsealed cars, but there is little prospect that much of the refrigerant will be made available for such use."

NEWS OF THE MONTH

Grants Fund for Corrosion Research

PITTSBURGH—Plans have now been completed whereby the American Society for Metals will provide an annual fund of $1000 for the support of fundamental researches in the field of corrosion. The American Coordinating Committee on Corrosion has been designated to receive and approve applications for grants from this fund. To this end, the Coordinating Committee has named a subcommittee on research under the chairmanship of Dr. R. M. Burns, assistant chemical director, Bell Telephone Laboratories, New York.

Qualified investigators desiring to receive grants from this fund are advised to address a formal application in quintuplicate direct to Dr. Burns. The application should recite the applicant's educational background, experience, and present affiliations, and set forth briefly but clearly the proposed research for which the grant is requested. A statement of the amount of money desired will be helpful. The application should be accompanied by three formal letters of recommendation signed by persons personally acquainted with the applicant.

Successful candidates must agree to communicate the results of researches supported by this fund to the Secretary of the American Coordinating Committee on Corrosion, 4400 Fifth Avenue, Pittsburgh.

Purdue to Explore Heat Transfer

LAFAYETTE, IND.—G. Stanley Meikle, research director of the Purdue Research Foundation and A. A. Potter, dean of the Schools of Engineering, announce the establishment of a new joint industry education enterprise at Purdue University for the "intensive training of graduate students in exploring the field of heat transfer for data upon which many of the practical developments of the future depend."

Made possible by a $75,000 grant from Westinghouse Electric and Mfg. Company, the five-year training and research program will be directed by Dr. George A. Hawkins of the Purdue faculty who has been appointed Westinghouse Research Professor in Heat Transfer.

Dr. Max Jakob of the Illinois Institute of Technology, whom Dean Potter described as "one of the world's greatest authorities on heat transfer", will cooperate with Dr. Hawkins in the capacity of non-resident Research Professor. Dr. Hawkins will select his research associates, known as fellows, who will seek new fundamental facts concerning the transmission of heat. For their experiments the research fellows will have access to the heat transfer laboratory of the School of Mechanical and Aeronautical Engineering built on the Purdue campus in 1927, as well as facilities in other departments of the University. Dr. Hawkins has been a member of the Purdue faculty since 1930.

Winslow Named Editor of Public Health Journal

NEW YORK — The appointment of Professor C.-E. A. Winslow as editor of the American Journal of Public Health, succeeding Harry Stoll Mustard, M.D., is announced by the American Public Health Association. The new editor takes office with the April issue.

Professor Winslow is Anna M. R. Lauder Professor of Public Health at Yale University, New Haven, Conn. His identification with the American Public Health Association has been long and intimate.

He is as well known among heating and ventilating engineers, bacteriologists, and housing experts as to public health workers, and is currently first vice-president of the ASHVE.

"Little Big Inch" in Action

WASHINGTON—The first batch of heating oil to arrive on the East Coast through the "Little Big Inch" pipeline reached the Linden, N. J., terminal at 5 a.m. March 4 from Texas.

The line began delivery of oil at the terminal during that week.

The "Little Big Inch" is the fifteenth pipe-line project to begin actual operations under PAW's overland transportation program to speed petroleum and petroleum products from the Southwest and Midwest to the consuming areas on the Atlantic Seaboard. Commenting on the operation of the line, Petroleum Administrator for War Harold L. Ickes said:

"Important as this line will be in helping us in our struggles to maintain heating oil supplies, it certainly will not mean that our troubles are over. As the result of the heavier demand that has come with colder weather, mounting requirements of the armed forces, and the continuing series of supply problems which have beset us all through this heating season, stocks are far too low for comfort.

"Continued prudence by heating oil and kerosene users is essential if we are to get through the winter without widespread hardship."

Initial deliveries through the Little Big Inch will average between 120,000 and 125,000 barrels of heating oil daily. War Emergency Pipe Lines expects deliveries to be stepped up to 150,000 barrels daily within a short time.

The "Little Big Inch" line is a 20-inch pipe line that extends 1,475 miles from Beaumont, Texas, to Linden, N. J. Throughout most of the route, the 20-inch line lies parallel to the 24-inch ("Big Inch") pipe line that extends from Longview, Texas, to the Philadelphia and New York refining areas.

Central Heating Makes City Clean

VIRGINIA, MINN.—When the last large group of citizens hooked up with this city's heating network recently, Virginia became the first community in the country where a central heating system provides steam heat for all homes, stores, schools and churches in the city. The community has a population of 12,264.

The municipally-owned heating system, operated as a non-profit enterprise, burns 43,000 tons of bituminous coal a year at $7 a ton.

The average householder in a five-room house in the city pays $70 a year to have his house and water heated, about half of what it is claimed it would cost on an individual basis. In addition, the community and its residents profit through an auxiliary use of the central heating plant, since the steam is first used to generate the electricity the town uses before it is piped into homes and business establishments.

Every street in town has a steam main, and a master thermostat controls the temperature in the individual houses. Condensate is weighed and recorded by a meter before it is discharged into the sewer.

The one central heating plant has made the city virtually smokeless, it is said, resulting in lower cleaning bills, fewer colds, less laundry and better morale for citizens. There are no ash cans, eliminating some refuse collection problems for the city, dwelling fires are down to 40% and Virginia's store owners receive a 5% "protective credit" on their insurance premiums.

Study Strato Effects on Humans

LOS ANGELES—A series of high-altitude tests designed to cover a period of approximately three months, is underway at the laboratory of the AirResearch Manufacturing Co. of Los Angeles by three members of the staff of the University of Southern California to determine the effects of rarified air on the human body.

Under the auspices of the Washington office of Scientific Research and Development, Drs. D. R. Drury and Howard Wilkins daily enter a Stratolab at the company's plant and "ascend" to 40,000 feet.

Among the major objectives are the determination of the effect of rarified air on the heart and lungs and how the human mind reacts to stratospheric conditions over given periods. Dr. Drury serves as the subject inside the Stratolab, with Dr. Wilkins as his observer, and Dr. Greeley acting as recorder outside the test chamber.

As the crew of the AirResearch Co. laboratory mans the controls which draw air into the chamber, the doctors sit quietly until the altimeter reaches the 10,000 foot mark. Then they adjust their oxygen masks and begin their observations and notations. Dr. Greeley, at his post outside the heavy glass window of the chamber, notes Dr. Drury's heartbeats as they are telegraphed through the chamber walls by an electro-cardiograph. A constant reading of the patient's breathing throughout the ascent is recorded on a spirometer. At the equivalent of 40,000 feet, Dr. Wilkins conducts a blood and lung test on Dr. Drury while Dr. Greeley makes final calculations from an instrument panel on the outside.

Detailed analyses of the blood and lung gas specimens are made immediately after the two doctors emerge from the test chamber upon making the gradual "descent." The doctors believe they will complete the study about June 1 and are confident the experiments will provide information of importance to ever higher penetrations into the stratosphere.

ASRE to Meet in Pittsburgh

NEW YORK—The 31st spring meeting of The American Society of Refrigerating Engineers will be held June 5-7, at the William Penn Hotel, Pittsburgh, A. B. Stickney, president of the Society has announced.

Emphasis in the technical sessions scheduled for Monday morning and afternoon, June 5, Tuesday morning and Wednesday morning will be on current developments in the design and application of refrigeration equipment, according to Clifford F. Holske, chairman of the Society's program committee. Definite acceptances have been secured from authorities who will present papers on frost zone psychrometry, hydrocarbon refrigerants, cold cathode lighting for refrigerated spaces, and effect of unstable heat flow on rapid temperature changes in confined spaces, refrigeration in synthetic ammonia production, and other subjects of equal timeliness.

Underwriters Laboratories 50 Years Old

CHICAGO—Underwriters' Laboratories, Inc., 207 E. Ohio St., Chicago 11, Ill., is celebrating its first 50 years of service. The Laboratories was an outgrowth of the first Chicago World's Fair, the Columbian Exposition of 1893. During the Fair a number of fires occurred in the fairground buildings, some caused by the at that time new incandescent bulb lighting. Apprehensive that this new lighting method would prove hazardous, insurance interests in Boston sent a man to Chicago to investigate the situation. This represented the beginning of the Laboratories.

Pipe Lines' Future Discussed

NEW YORK—"The War Emergency Pipe Lines cannot compete with tankers for petroleum transportation from the Gulf Coast area to the East Coast in the post-war period and only enough petroleum transportation business is in sight to give one segment of one line an economic load from the Texas area into the Midwest," predicted T. E. Swigart, president of Shell Pipe Line Corporation, in a paper discussing the possible post-war uses of the Big-Inch and Little-Inch pipe lines delivered recently here before the petroleum division of the American Institue of Mining and Metallurgical Engineers.

Mr. Swigart's speculations as to the post-war usefulness of the War Emergency Pipe Lines were premised on a belief that the government, in keeping with American principles of private enterprise, will sell or lease the lines to private industry after the war is over. If such proves to be the case, it is not likely, he believes, that a single shipper of petroleum will have enough transportation business to justify his purchase of one of the lines for his own use. A group of oil companies will probably be the only parties who can guarantee enough business to either of the lines to give them an economic load and thus justify their purchase and operation.

Frank Addresses Foundrymen

LOS ANGELES—Foundry Dust Control was the subject of a talk presented at a recent meeting of the Southern California Chapter, American Foundrymen's Association, by W. G. Frank, chief engineer, dust control division, American Filter Corp., Inc., Louisville.

Illustrating his talk with slides, Mr. Frank discussed dust control in all the phases as it affects foundries. He cited the present interest of foundry operators in the control of dust and explained design and function of various dust control units and installations in foundries in various parts of the country.

Forecasts Big Construction Market

WASHINGTON—A $26 billion program of public works and other public construction, consisting entirely of urgently needed and desirable projects, was forecast for the five-year period starting twelve months after the end of the war, in a statement issued March 18 by Russell G. Creviston, general postwar chairman of The Producers' Council, national organization of manufacturers of building materials and equipment.

Although the volume of new public construction would be less than half as great as the estimated amount of private building during the period in question, the expenditures for needed projects to be financed by Federal, state, and local governments would be sufficient to provide annual employment for more than 2,000,000 on-site and off-site workers and should remove all need for resorting to work relief plans or the building of non-essential public projects merely to provide employment after the war, Mr. Creviston stated.

A.C. Code for Phoenix

PHOENIX, ARIZ.—Submission of a proposed air conditioning and refrigeration code for Phoenix by the Arizona Refrigeration Association was announced here Feb. 21 by City Manager Roy J. Heyne, to whom the code was referred for study.

Roy L. Perry, Baker Ice Machine Co., president of the association, said that the 43-page proposal, covering the subject from administration to cooling towers and unit refrigerators, was drafted by an association committee and is similar to code now effective in Los Angeles.

Contractors to Meet in Cleveland

NEW YORK—The fifty-fifth annual convention of the Heating, Piping and Air Conditioning Contractors National Association will be held at the Hotel Statler, Cleveland, May 31-June 2. Subjects for discussion include training and testing welding operators, formation of welding bureaus and their operation, home heating, selling heating, employer-employee relations, and post war plans.

Arrangements for the convention are in the hands of a national convention committee consisting of George P. Nachman, Cleveland; Arthur F. Nass, Pittsburgh; Joseph C. Fitts, New York; and a local convention committee consisting of Walter Klie, M. D. Lavelle, Fred Schweizer and Herman Eckhardt, all of Cleveland.

ASRE Forms West Coast Section

NEW YORK—The council of The American Society of Refrigerating Engineers has approved the petition of a group of members in the San Francisco area for the formation of a local section, the 16th recognized local group of the 39-year-old Society. Members in that city have fomed their local organization, electing the following executive committee: Nels Rosberg, Merchants Ice & Cold Storage Company, chairman; Kenneth D. McGrew, Van Arsdale-Harris Company, secretary; Harry T. Holbrook, Union Ice Company; Edward Simons, Redwood Manufacturers Company; and Harry T. Whyte, Pacific Fruit Express Company.

Propeller Fan Makers Elect Englert

NEW YORK.—The Propeller Fan Manufacturers Association held its annual meeting here last month at the Pennsylvania Hotel, at which time the following new officers were elected for the coming year: president, E. C. Englert; vice-president, Wallace Allen; and secretary-treasurer, V. C. Shetler.

The Association has appointed a postwar committee which is carrying on a survey to investigate trends and markets for the postwar period.

The Association will meet again April 11, at Hotel Statler, Detroit.

Ickes Opposes Coal Rationing for 1944-45

WASHINGTON — Solid Fuels Administrator Harold L. Ickes said March 16 that despite the situation in the coal fields, where shortages of manpower and machinery make increasingly difficult the achievement of production goals, he was opposed to the rationing of coal.

"We are against it," Mr. Ickes said, speaking as Solid Fuels Administrator for the officials of that agency, by all of whom rationing is declared to be regarded as a system too inflexible for successful adaptation to the coal industry, because of the readjustment necessary to enable the routing and rerouting of coal to sections most in need at a given time, readjustments which they are said to feel would be difficult if not impossible with a rationing system in operation.

Correction

In Part 12 of the series "How to Design Hoods," page 52, HEATING AND VENTILATING, February 1944, the following corrections should be made in Problem *A*. Change hood dimensions from 4 in. x 8 in. to 8 in. x 16 in. Similarly for Fig. 85, leaving other dimensions as they are. The air volume handled as given in paragraph 5 should read: Air volume through opening = 1750 x 8 x 16 = 1560 cfm.

Laboratory Moves to Cleveland

CLEVELAND—The Research Laboratory of the American Society of Heating and Ventilating Engineers which has been located in the building of the U. S. Bureau of Mines in Pittsburgh, Pa. for the past 25 years, was moved on March 15 to its new quarters in Cleveland.

The new location is a 3-story building at 10700 Euclid Ave., Cleveland 6, Ohio, at the corner of E. 107th St. and Euclid Ave. It has exterior dimensions of 91 x 57 ft. A two year lease has been signed with the owners on terms considered favorable to the Society.

A formal inspection of the Laboratory by the council is planned for April 30.

Downey Heads IUHA

CHICAGO — At the eighteenth annual meeting of the Industrial Unit Heater Association held here March 2, the following officers were elected for the ensuing year: N. Downey, president; C. E. Scott, vice-president; and L. O. Monroe, secretary-treasurer.

Warm Air Group Will Discuss Fuels

CLEVELAND—The National Warm Air Heating and Air Conditioning Association will hold its mid-summer meeting at the Stevens Hotel, Chicago, June 7 and 8. Results of the research program carried on during the past winter on smokeless furnace operation will be discussed by Professor A. P. Kratz of the University of Illinois. Professor S. Konzo will present the new Forced Warm Air Manual and Warm Air Text Book which is now being prepared.

Dr. Ralph Sherman of the Battelle Memorial Institute will discuss fuel resources of the future. Gas heating and oil heating will also be covered.

T. Reid Mackin, International Heater Co., is chairman of the Chicago convention committee.

James L. Goodwin

HARTFORD, CONN.—James L. Goodwin, president of The Whitlock Mfg. Co., Hartford, died January 28. He was active in the Company up to the time of his death but had been in ill health for some time.

Mr. Goodwin joined the organization, then called the Whitlock Coil Pipe Co., in 1906. In the ensuing thirty-eight years he held at various times the offices of treasurer, secretary, general manager, vice-president and president. At the time of his death he had been president for over nineteen years.

Louis Narowetz

CHICAGO.—Louis Narowetz, founder of Narowetz Heating and Ventilating Company, and former president of the Building Construction Employers Association in Chicago, died March 5 following an operation.

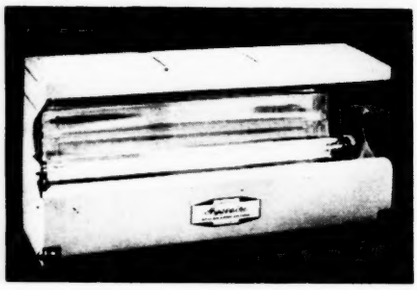
Mr. Narowetz, born in the Black Mountains of Europe in 1866, served an apprenticeship as a millwright and metal worker. He came to this country in 1887, became a citizen, and attended night school in Chicago. He began his own business in 1903 and contracted the ventilating work in structures as the Commonwealth Edison, Illinois Bell Telephone and Sears Roebuck; in 1910 completed the Hotel Sherman and, shortly after, the Chicago and Northwestern Railroad Station in Chicago. He invented a number of items of equipment, among which was the little Niagara air washer.

Mr. Narowetz was a member of numerous lodges, clubs, and other organizations. He was married in 1899 and from this union four daughters and one son were born, all of whom are still living. Eight grandchildren and one great grandson also survive.

NEWS OF EQUIPMENT AND MATERIALS

Hygeaire

NAME—Hygeaire.
PURPOSE—Ultraviolet germicidal radiation system for use in plants, offices, and homes for combating air-borne infection.
FEATURES—System is combination of the G. E. germicidal tube and a pat-



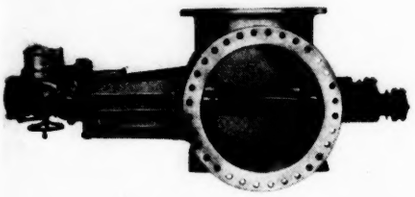
ented reflector in the fixture designed to project a zone of protection across an area above eye-level. It is claimed that air-borne bacteria and viruses are carried into the zone of ultraviolet rays and to their deaths by convected air currents, giving to the protected space the germicidal effect of 100 air changes per hour.
MADE BY—*American Sterilizer Co., Erie, Pa. Graybar Electric Company and General Electric Supply Corp. are the distributors.*

Portable Dust Collector

NAME — Norblo portable dust collection unit.
PURPOSE—For light dust loads and intermittent service.
FEATURES — Embody same principles as are used in Norblo bag-type systems for large scale dust collection. Are liberally powered, designed to meet code requirements, which are becoming increasingly stringent. The bags are cleaned by hand shaking. Capacities range from 300 cfm up, up to 8 in. static pressure at the fan. Also available for wet or moist grinding or polishing or where lint or fibrous fabric is produced, is a line of impingement and filter type small units, ranging from 500 to 1000 cfm with 8 in. static at the fan. Filter type units cost less than bag-type, but maker emphasizes that they should not be considered as alternative but that either type should be selected on basis of dust load characteristics.
LITERATURE AVAILABLE—Norblo Portable Bulletin.
MADE BY—*The Northern Blower Co., 6506 Barberton Ave., Cleveland 2, Ohio.*

R-S 3-Way Valve

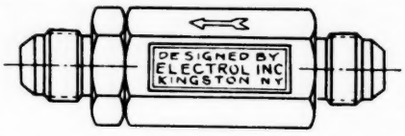
NAME—R-S three-way valve No. 604.
PURPOSE — Designed for quick interchange and mixing service.



FEATURES—Valve is of the butterfly type and is designed for manual control or power-operated service. Dual-finned, lubricated stuffing boxes are provided for elevated temperature and high working pressure.
SIZES AND CAPACITIES—For pressures from 15 to 900 psi. Weight of motor-operated unit is 8500 lb.
MADE BY—*R-S Products Corporation, Wayne Junction, Philadelphia 44, Pa.*

Check Valve

NAME—Electrol No. 227 check valve.
PURPOSE—For checking flow of any fluids.
FEATURES—Device is fabricated entirely of aluminum with the exception of a small spring and two toroid seals, thus conserving critical metals and effecting a saving in cost.



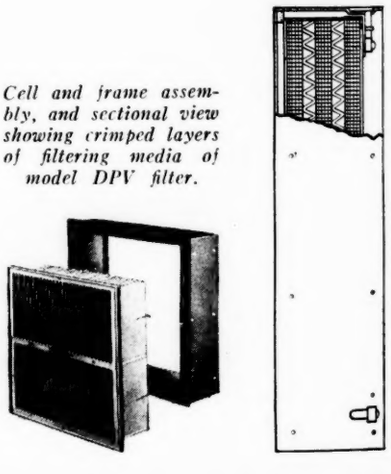
SIZES AND CAPACITIES — Made in 9 sizes for outside tubing diameters of ⅛ to 1 in. and with capacities of 0.2 to 29.0 gpm.
MADE BY — *Electrol Inc., Kingston, N. Y.*

Thermo-Pilot

NAME—Perfex Thermo-Pilot.
PURPOSE — Stoker control replacing the conventional clock timing mechanism.
FEATURES — Device has two simple movable units. An electric current supplies heat energy to bimetal element. When sufficient heat has been stored in bimetal element a circuit is closed which energizes stoker relay and places stoker in operation. As bimetal element cools, relay is de-energized, stoker stops and cycle is repeated. This hold-fire operation can be adjusted for short, medium or long operating periods at from one-half to one hour intervals to meet operating requirements. Safety switch prevents hold-fire operations immediately after stoker has been in operation at command of thermostat. There is no subsequent over-shooting of room temperatures. Elimination of complicated timing mechanisms is said to result in longer life, less wear and reduced servicing.
MADE BY—*Perfex Corp., Milwaukee, Wisc.*

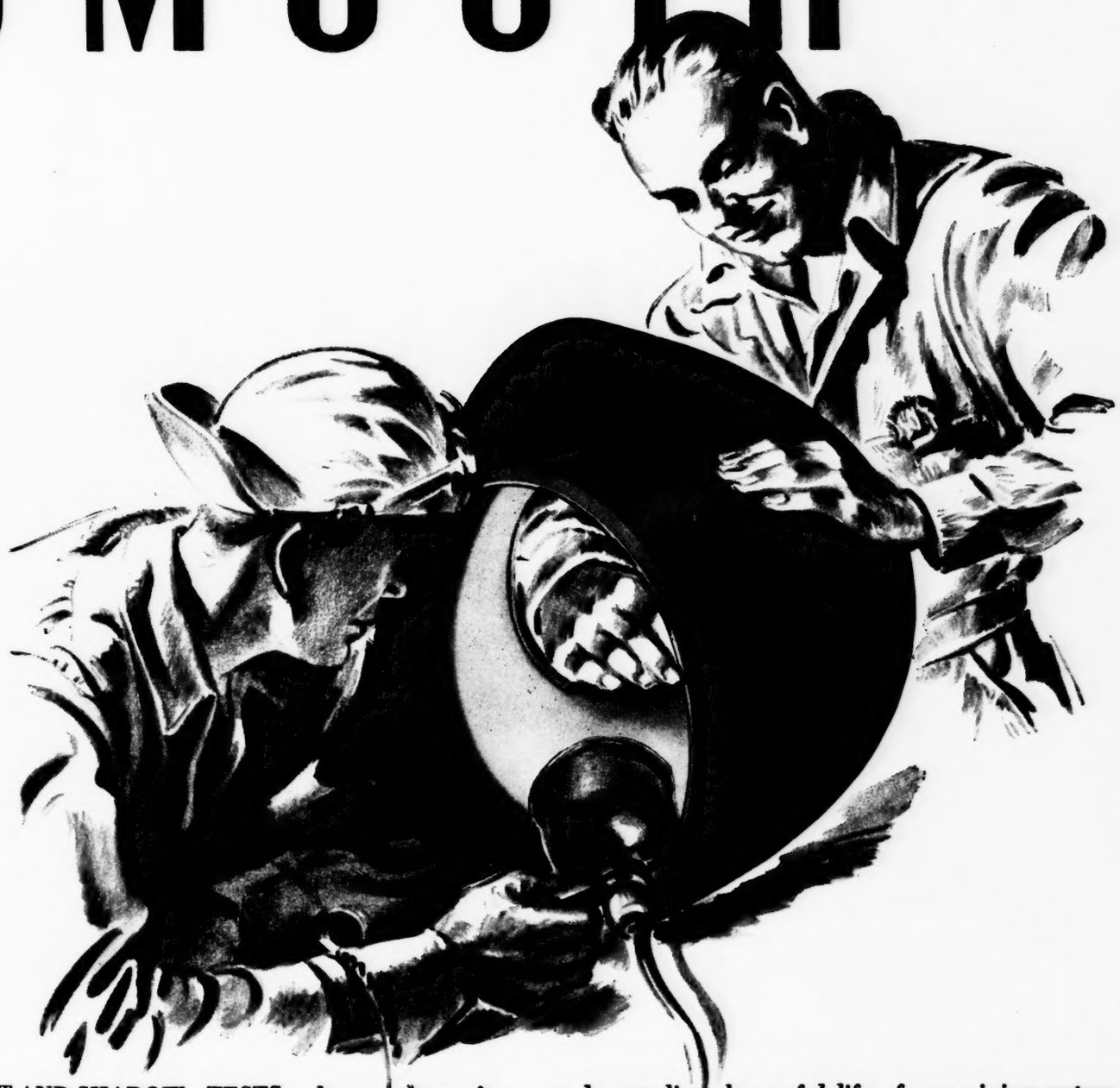
Panel Filter

NAME—Staynew model DPV viscous panel filter.
PURPOSE—For application in ventilating and air conditioning systems where filter resistance up to approximately 0.60 in. of water is permissible.
FEATURES—Filtering medium consists of a series of crimped layers of galvanized screen cloth and woven copper mesh. This medium is coated with Pingene PD-10 filter oil. The medium is so arranged within the metal cell that it provides large dirt-holding capacity, thus requiring minimum of servicing. Cells are heavy, being made of 16-gage steel finished with a corrosion-resisting paint, and are fitted with handles and cam-type locking latches which hold the cell tightly in place in its box-type supporting frame, thus sealing the unit against air leakage. Box-type supporting frames are so designed and drilled that they can be riveted together to form a flat bank, or, by the addition of angles, a series of V's so that a maximum of filter capacity can be installed for any given space.
MADE BY—*Dollinger Corp., Rochester, N. Y.*



Cell and frame assembly, and sectional view showing crimped layers of filtering media of model DPV filter.

SMOOTH



LIGHT-AND-SHADOW TESTS, shown above in Tube Turns' Inspection Department, instantly reveal any rough wall surfaces.

Smooth inner walls are vital in welding fittings. For waves, ridges or "pockets" retard flow, increase pressure loss and accelerate corrosive and erosive action. Absence of surface irregularities permits maximum operative efficiency, reducing maintenance and extending the useful life of any piping system.

Tube-Turn welding fittings are *always* made with uniformly smooth inner walls. Continuous light-and-shadow tests *insure* this superior feature in all Tube-Turn seamless welding fittings.

TUBE TURNS (Inc.) Louisville, Kentucky. *Branch Offices: New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, San Francisco, Seattle. . . . Distributors located in all principal cities.*

ARMY E NAVY M

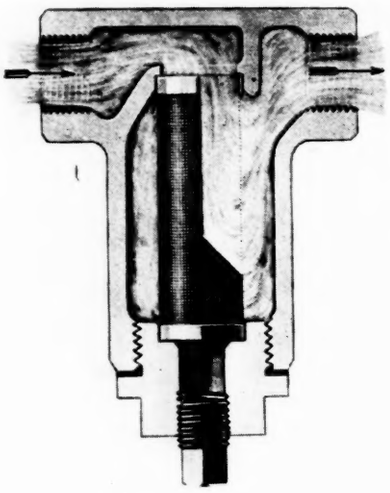
TUBE-TURN

TRADE MARK

Welding Fittings and Flanges

Liquid Strainers

NAME—Types TW and Q strainers.
PURPOSE—TW for installations involving the use of several nozzles on a single feed line; Q for single nozzle installation.
FEATURES—Design of TW strainer (illustrated) results in large open screen area in relation to pipe area of line, so that it may handle full capacity of line supplying several nozzles. Blowout plug makes device



easy to flush and clean without removal from the line. Supplied with cast iron body and brass wire screen; all brass or all stainless steel construction is also available. With type Q maximum capacity of strainer is one gallon per minute of water, brine, oil and liquids of similar viscosity. Screen in this strainer is removable to facilitate cleaning, and is available in several materials.
MADE BY—*Spraying Systems Company, 4031 West Lake St., Chicago 24, Ill.*

Welding Cooling Unit

NAME — Chrysler Airtemp packaged resistance welder cooling unit.
PURPOSE—For cooling resistance spot welders and for other specialized industrial liquid cooling service.
FEATURES — Unit is completely self-contained, equipped with Airtemp hermetically-sealed radial compressor. Has ample capacity to cool all types of resistance spot welders when handling aluminum or ferrous metals. Tip cooling of spot welders makes it possible not only to increase the welding speed, but also reduces the amount of tip cleaning and dressing necessary in average welding operation. When a continuous number of welds are made tip temperature tends to increase and for this reason ample capacity is necessary in the refrigerating mechanism to keep the tips at the desired temperature. Has counter flow liquid cooler mounted in base. Insulated storage tank is equipped with a ¾ hp pump with nominal capacity of 6 gpm. Location of liquid cooling unit in base eliminates losses of coolant at time of changing tips, as all liquid drains back to the storage tank. A pressure regulating valve assures flow of coolant at a constant pressure. Cylinder liners are removable and interchangeable, and each cylinder is protected by a suction strainer. Oil separator is standard equipment. Compressor starts unloaded. Motor is equipped with a magnetic across-the-line starter, and has built-in overload and low voltage protection with external hand re-set. Steel condenser is equipped with a 16-in. propeller type fan. Has high pressure cut-out.
SIZES AND CAPACITIES—1½ hp unit. Has remote bulb thermostat, with temperature range from —20F to 20F for temperature of coolant.
MADE BY—*Airtemp Division, Chrysler Corporation, Dayton, Ohio.*

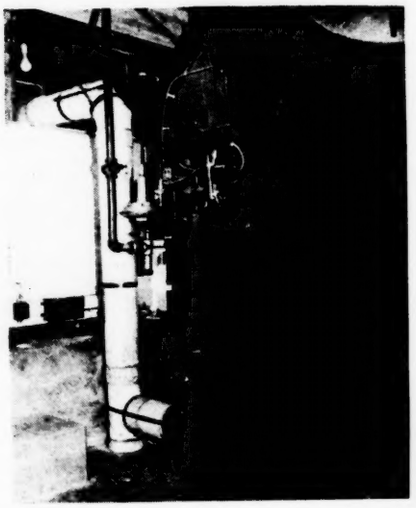
Oil-Rite Lubricator

NAME—Oil-Rite constant level type lubricator, Type J.
PURPOSE — Automatically-controlled visible oiling method for all types of bearings.
FEATURES—When reservoir is filled with oil, only enough oil will be released from reservoir to bring level in bearing oilwell to the oil level line marked on base. When bearing oil level falls, air is admitted into reser-

voir through a vent thus releasing enough oil to restore original level. Device consists of three parts: base, dome, and reservoir. In base are a bottom and side outlet for connection to bearings, either or both of which may be used. In center is a large air intake opening which can be connected to a filter or to a breather tube on bearing. Reservoir is sealed to a collar with a new type of plastic cement providing a stronger bond than on earlier models and is not affected by oil, water, heat, or acid.
SIZES AND CAPACITIES—Available in 4 standard sizes with capacities of 2, 4, 8, and 16 oz.
MADE BY—*Oil-Rite Corp., 3473 S. 13 St., Milwaukee 7, Wisc.*

Dravo Control

NAME—Control for gas burning direct fired warm air heaters.



PURPOSE—A dual control by which at least 25% capacity of the heater is worked on straight on-off basis and the balance modulated to fit needs.
FEATURES—Intended for heaters manufactured by Dravo. Said to give economy in fuel and uniformity in heat output. Also useful for tempering large quantities of ventilating air frequently used in connection with heating systems of this type.
MADE BY—*Dravo Corp., Neville Island 25, Pittsburgh, Pa.*

Red Flash Water Heater

NAME—Pick Red Flash tankless hot water heater.
PURPOSE—To heat water with steam.
FEATURES—Water is heated through blending with steam within injection chamber. Unit is self-contained, compact design, and needs no storage tank. Made in three types, fully automatic, semi-automatic, and non-automatic.
SIZES AND CAPACITIES—Made in 7 sizes with capacities ranging from 10 gpm to 200 gpm at any specified temperature rise between 20F rise and 140F rise. Minimum ratings approximately 40% of maximum ratings given. Operates on water pressures from 20 to 100 lb, steam pressures from 40 to 100 lb.
MADE BY—*Pick Manufacturing Co., West Bend, Wisc.*

jumbo problem:

heat one of America's largest bomber plane modification centers . . .
35 acres under one roof . . . 108,000,000 Btu per hour . . .
400,000 sq. ft. of non-metallic duct work . . .

The size alone of this vast structure presented an unusually difficult problem of heat distribution. In addition, the building was broken up into ten hangars and three service bays, each bay containing a machine shop and offices. Due to the great height of the bomber planes no part of the heating system could be installed lower than forty feet above the floor in the hangars. The throwing of warm air from a forty foot height required correct air velocity and diffusion to permit heated air to reach the floor level and to minimize the differential between floor and ceiling.

solution: Setting a new standard in the heating of large hangar areas this building required one of the largest direct-fired forced air heating systems ever installed. Six central heating rooms were constructed, each room containing three Dravo heaters totaling 18,000,000 Btu capacity and operating into a common header. From this the extensive overhead duct system distributed warm air to the hangars, service bays and numerous offices. Each heater was coal fired by a stoker that was fed from a bin built underneath the concrete runway. This Dravo method proved most satistactory and was later used to heat two smaller but similar modification centers in the Southwest.

Write for Bulletin 509

DRAVO

Heating

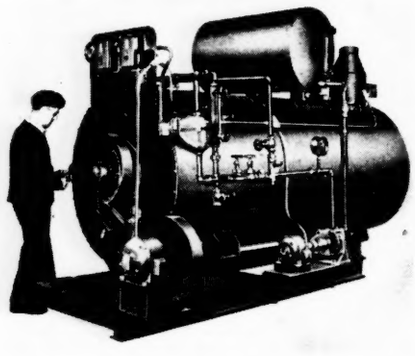
DRAVO CORPORATION, PITTSBURGH

Light Weight Insulating Board

NAME—Thermo-setting plastic binder to bond glass fibers.
PURPOSE—To provide a rigid hull insulating board for Navy and Maritime Commission vessels.
FEATURES—Has a density of 7¾ lb per cu ft, possesses thermal insulating qualities of the 9 lb board formerly supplied by the manufacturer for this purpose. Lighter board will effect a material weight saving in the vessels in which it is installed, and because it requires a lesser quantity of glass fibers, will aid the manufacturer in supplying the greatly increased quantities of the board called for by the Navy ship-building program. Use of the lighter board will result in saving up to 2700 pounds in the overall weight of larger vessels of the Navy's landing craft type.
MADE BY — *Owens-Corning Fiberglas Corp., Toledo, Ohio.*

Powermaster Steam Generator

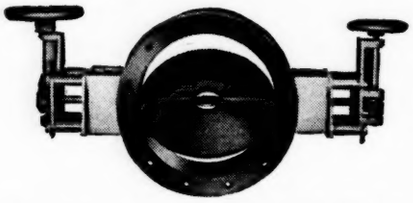
NAME—Powermaster steam generator
PURPOSE—Compact oil fired steam generating unit for process power and heating. Presently used by Army in mobile laundry units. Also recommended for food processes, laundries, dairies, and similar applications.
FEATURES — Unit is said to develop 100 lb pressure from 60F water in 18 minutes. Has 3-pass construction, said to require little cleaning, built-in condensate return system. Includes automatic low water cut-off and usual steam specialties. Controls include a selector switch, main switch, magnetic switch for larger units, starting switch for water pump, low voltage cut-out, pressure control stack switch.



SIZES AND CAPACITIES—Designed for 100 or 125 lb working pressure. Several sizes with capacities from 10 to 100 hp.
LITERATURE AVAILABLE—Bulletin 1213
MADE BY—*Orr & Sembower Inc., Reading, Pa.*

Butterfly Valve

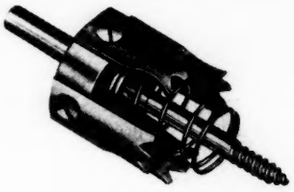
NAME—R-S 608 butterfly valve.
PURPOSE—For either high pressure drop and low volume or low pressure drop and large volume.



FEATURES — Operates beyond limitations of a single valve. Close control and shut-off of volume and pressure can be obtained; valve easily adapted to power operation. Larger beveled vane seats against body of valve, while smaller vane is free revolving. Four to six revolutions of the hand wheel completely open or close either valve vane.
SIZES AND CAPACITIES — Available in various combinations for operating pressures of 15 to 900 lb per sq in.
MADE BY—*R-S Products Corp., Wayne Junction, Philadelphia 44, Pa.*

Insulation Hole Cutter

NAME—Circo insulation hole cutter.
PURPOSE—Circular tool for cutting holes in building sheathing to accommodate pipes required to blow insulation into walls of old buildings.



FEATURES—Tool is designed for use in portable drill. Four cutting blades. Pilot has self-starting screw point. Cutter is equipped with ejector spring which throws block out as hole is cut. As a result, block does not jam between blades.
SIZES AND CAPACITIES—Cuts holes in 1 in. sheathing 2½ in. in diameter in a few seconds.
MADE BY—*Circo Tool Company, 902 West Vliet St., Milwaukee 5, Wisc.*

Rivnut

NAME—Rivnut.
PURPOSE—An internally threaded and counterbored tubular rivet which can be headed blind.
FEATURES—Made from corrosive-resistant aluminum alloys. Of one-piece construction, Rivnut is anodized and ready for use when received. Installed, Rivnut serves as a nut plate or rivet, or both.
SIZES AND CAPACITIES — Two head styles, countersunk and flat, are offered, with countersunk made in three shapes, flat in one. Each made in three nominal sizes, available in six grip ranges.
LITERATURE AVAILABLE — 12-page bulletin.
MADE BY — *The B. F. Goodrich Co., Akron, Ohio.*

Wheelco Chronotrols

NAME—Wheelco Chronotrols.
PURPOSE—A line of instruments to provide automatic temperature regulation regardless of changes of temperature desired for all given processes or applications.
FEATURES—Device employs an electric principle of temperature control. Temperature cycle desired is cut on

a disc, and its rotation by a synchronous motor moves temperature setting lever of control instrument. Absence of mechanical linkage between measuring and control sections said to make possible instant response of instrument's control unit to changes in temperature noted by its sensing unit. Frequency of oscillating current flowing between pick-up coils, mounted on temperature control setting index, is changed when control flag mounted on pointer or pen arm is moved between coils by a temperature rise, or is moved from between coils by a temperature drop. This frequency change in the control circuit governs the output current of a vacuum tube, acting to open relay contacts which, in turn, operate fuel valves or switches.
SIZES AND CAPACITIES—In 25 models, including ten for proportioning control and others for two-position on-off and three-position on-intermediate-off control for high- and low-temperature applications. Thermometer models are available in recording as well as indicating types.
MADE BY—*Wheelco Instruments Co., Harrison and Peoria Sts., Chicago 7, Ill.*

ANGLE FACTORS FOR RADIANT HEATING AND COOLING

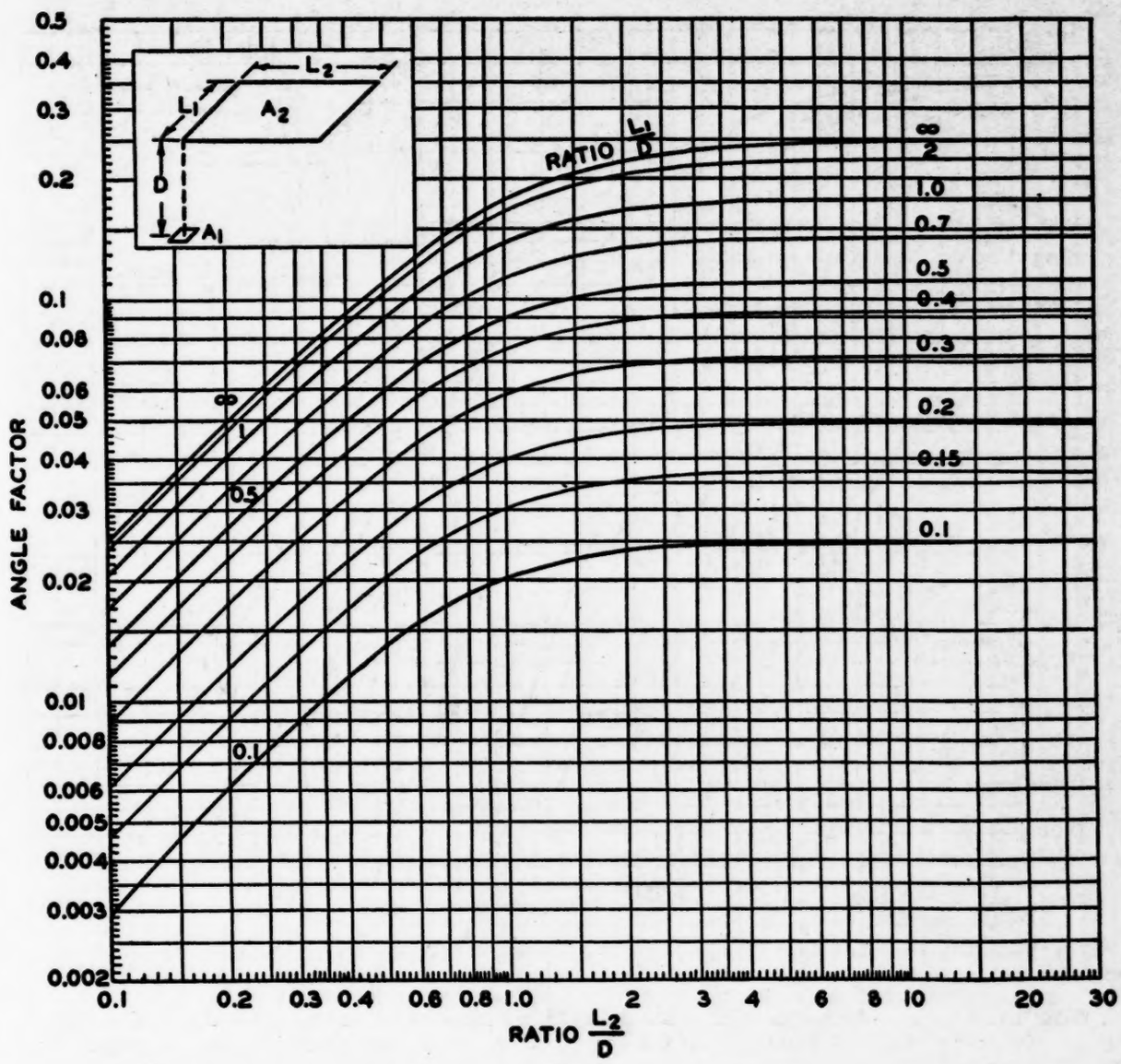


Fig. 1

Charts shown on this sheet and on Reference Data 269-270 and 271-272, to follow, give the values of angle factors for radiant heating or cooling calculations. All are from a study by the College of Engineering, Cornell University, as reported in Bulletin 32 of the Cornell University Engineering Experiment Station, entitled "Radiant Heating and Cooling, Part 1," by C. O. Mackey, L. T. Wright, Jr., R. E. Clark, and N. R. Gay, and presented here by permission.

Angle factor, as used here, *is the fraction of energy emitted in all directions from surface 1 which is in such direction as to be intercepted by surface 2.* Another definition would be *the ratio of energy intercepted by surface 2 to the total energy emitted by surface 1.*

Determination of the angle factors for the various cases to which the charts apply involved considerable mathematical manipulation, all based on Lambert's cosine law; the derivation is explained in the Cornell Bulletin 32 referred to above.

Figs. 1 and 2, the first of the series of five separate charts covering five different cases, are devoted to a relatively small emitting area (surface 1) and a relatively large intercepting area (surface 2) with the small area parallel (Fig. 1) or perpendicular (Fig. 2) to the large area, and with a normal from the corner of the large area passing through the plane of the small area (other cases are covered on Reference Data 269-270 and 271-272). For practical purposes data from Figs. 1 and 2 are applicable when surface 1 is small relative to surface 2.

It is convenient to use standard symbols in these calculations; on these sheets A, with various subscripts such as A_1, A_2, etc., is used for an area or surface. F is used to indicate angle factor, the subscript indicating (1) the emitting and intercepting areas and (2) the order of digits in the subscript indicating the direction of flow of energy. Thus $F_{1\text{-}2}$ designates the angle factor between Area 1 and Area 2, and, since the 1 appears first, Area 1 is the emitting area. Similarly, $F_{2\text{-}1}$ indicates that A_2 is the emitting area, A_1 the intercepting area.

It can be shown that $A_1F_{1\text{-}2} = A_2F_{2\text{-}1}$. This point is not only useful but necessary in more involved calculations presented later.

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ANGLE FACTORS FOR RADIANT HEATING AND COOLING

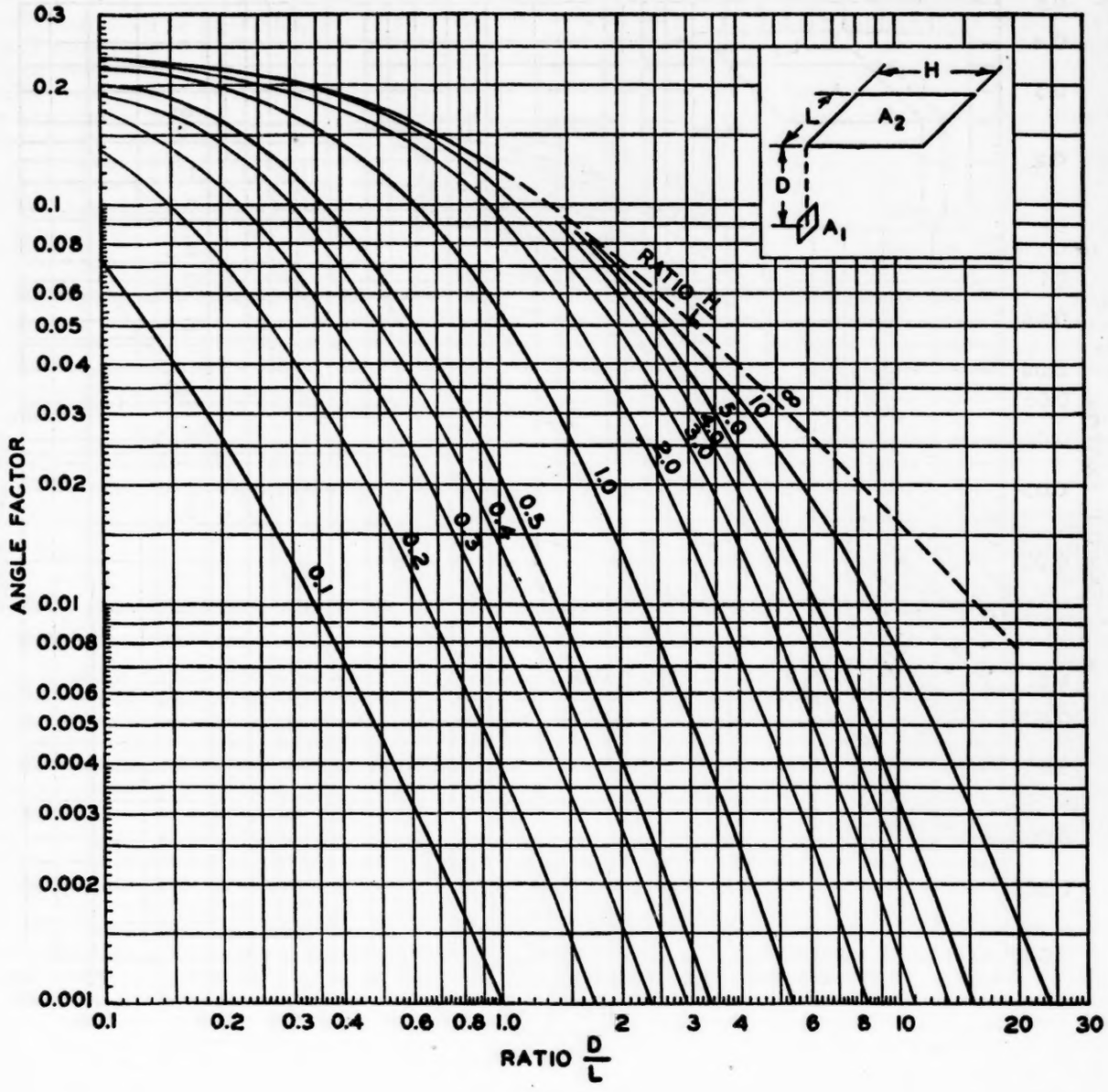

Fig. 2

In the case of Fig. 1, $\frac{L_1}{D}$ and $\frac{L_2}{D}$ are interchangeable. In Fig. 2, $\frac{D}{L}$ and $\frac{H}{L}$ are *not* interchangeable.

USE OF CHARTS

Problem: A 3 in. square plate is flat on the floor in the corner of a room 16 ft x 12 ft in plan and with a 10 ft ceiling. If the plate is heated so that it emits 100 Btu per hr, how much heat is intercepted by the ceiling?

Solution: Since the plate is quite small relative to the ceiling area, Fig. 1 applies.

The ratio $\frac{L_2}{D} = \frac{16}{10} = 1.6$; ratio $\frac{L_2}{D} = \frac{12}{10} = 1.2$.

Referring to Fig. 1, find 0.17 as the angle factor. Heat intercepted by the ceiling is 100 Btu x 0.17 = 17 Btu per hr.

Problem: The same plate stands on edge in the corner of the room with the plate parallel to the shorter wall. What is the heat intercepted by the ceiling?

Solution: In this case Fig. 2 is used, and L = 12 ft, H = 16 ft and D = 10 ft so that $\frac{D}{L} = \frac{10}{12} = 0.83$, $\frac{H}{L} = \frac{16}{12} = 1.33$. From Fig. 2, the angle factor $F_{1\text{-}2}$ = 0.084, so that the ceiling intercepts 100 x 0.084 = 8.4 Btu per hr.

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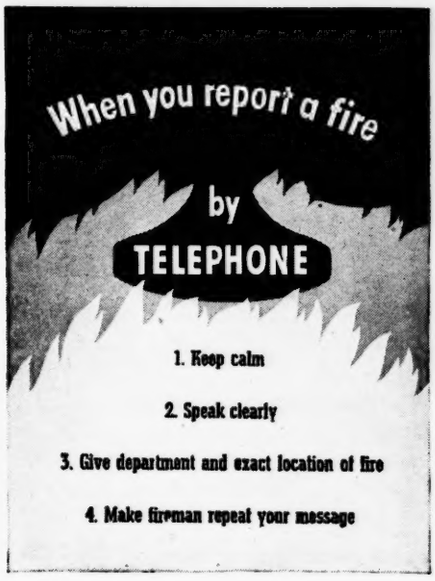
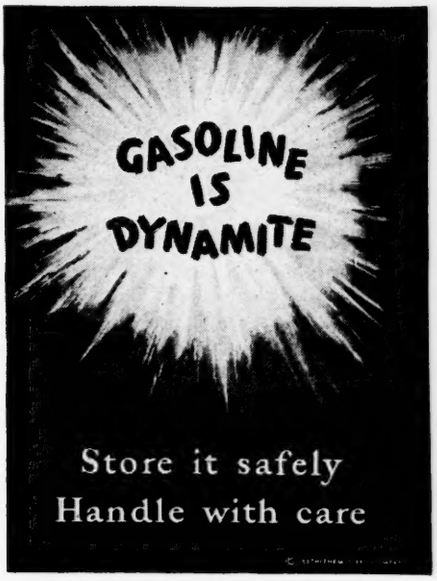


COME ON ED— STOP DAY-DREAMING IN FRONT OF THAT POSTER
THIS IS NO DREAM ...IT'S GOOD STUFF TO KNOW
HOW TO USE A FIRE EXTINGUISHER
MOTORS THROWIN' SPARKS ...BETTER SHUT DOWN!
LOOK OUT, ED— SHE'S ON FIRE!
THAT DAY-DREAM KIND OF PAID OFF ... HUH, BILL?

fighting fires with



POSTERS

Bethlehem has long had an efficient fire-fighting organization. But war conditions multiply normal fire hazards. Thousands of new employees have come to work. Large additions have been made to existing facilities, and entire new departments set up. At the same time, war needs have intensified the pressure for production.

Since the start of the war emergency Bethlehem has redoubled its effort to keep down production loss due to fires. Much new equipment has been provided: extinguishers, alarm boxes, sprinkler systems, hose outlets and fire engines. And as plants grew, fire-fighting personnel was expanded, and given special training.

BETHLEHEM STEEL

A poster campaign, of which a few representative samples are shown on this page, is one important detail of this program. Each poster registers in the employee's mind a single, specific point in fire-fighting or fire-prevention. Prominently displayed in steel plants, shipyards, fabricating shops, these posters are helping to maintain a favorable fire-loss record through the war years.

A fire on the production front can cost American lives on the battle-fronts. Even seemingly trivial fires have a grave cumulative effect. The aim is to prevent fires from occurring at all—and, if they do occur, to make them die young.

REVIEWS

HOT WATER HEATING

Bulletin No. 349, "Performance of a Hot-Water Heating System in the I-B-R Research Home at the University of Illinois," by Alonzo P. Kratz, Warren S. Harris, Maurice K. Fahnestock, and Ross J. Martin, which has just been issued by the Engineering Experiment Station of the University of Illinois, is the first to be published under a cooperative agreement between the Institute of Boiler and Radiator Manufacturers and the University of Illinois, which was formally approved January 2, 1940. A description of the I-B-R Research Home, which was built in Urbana, Illinois, furnished and completely equipped specifically for research work in steam and hot water heating, is given, as well as a discussion of the results of tests made during the 1940-41 and 1941-42 heating seasons. In all tests an oil-fired, cast-iron boiler supplying hot water to a one-pipe, forced-circulation, hot-water heating system with small-tube cast-iron radiators was used in the Research Home. The principal objectives of the tests were to compare the operating characteristics of the heating system when operated (1) with a control system permitting the boiler to be used to heat domestic hot water as well as to supply heat to rooms, and (2) with a control system permitting the boiler to supply heat to the rooms only. Fuel and power savings and room temperature conditions resulting from operating with reduced room air temperatures at night were determined for both methods of control. Incidental studies were made of the heat transmission through walls of the house and radiator recesses, and the effect of radiator location on the temperature distribution and air movement within the rooms. All windows remained closed throughout all tests.

Until September 15, 1944, or until the supply available for free distribution is exhausted, copies of Bulletin No. 349 may be obtained without charge upon application to Engineering Experiment Station, Urbana, Ill.

STEAMFITTING

More than twenty years of actual experience in teaching steamfitter apprentices is embodied in a three volume textbook course recently announced by the Heating, Piping and Air Conditioning Contractors National Association. The material in the three volumes is that selected by the Washburne Trade School in Chicago; publication of the book is the result of the active cooperation of employers and employees in Chicago's Joint Arbitration Board in the Steamfitting Industry. The books have been approved by the Heating, Piping and Air Conditioning Contractors National Association and the United Association of Journeymen Plumbers and Steam Fitters of the United States and Canada.

The books contain fundamental information on heating, piping, and air conditioning which the apprentice needs. Volume I is devoted to pipe work and heating; Volume II to steam power and refrigeration; and Volume III to air conditioning, process piping, welding, and brazing. In addition to the text given on the arts mentioned, subject matter on related science, mathematics, and drafting is included.

Sale is restricted to members of the association, regularly indentured apprentices in the trade, apprenticeship committees, instructors of apprenticeship classes and vocational schools. This restriction is necessary due to wartime conditions which made a limited edition necessary.

It is impossible to speak too highly of these books and the care which has been taken in presenting the information. They are not only thoroughgoing and complete but remarkably up to date, as evidenced by such examples as the pages on modern radiant heating installations.

Size 9 x 11¼ in., cloth bound. Volume I contains 617 pages; Volume II, 402 pages, and Volume III, 403 pages. Price, $5.90 per set, not sold separately. Available from the Heating, Piping and Air Conditioning Contractors National Association, 1250 Sixth Ave., New York 20, N. Y.

FUEL CONSERVATION

"Fuel Savings Resulting From Closing of Rooms and From Use of a Fireplace," a two-part study of investigations made by the University of Illinois Experiment Station and dealing with (1) the effect of closing off rooms and (2) the use of fireplaces in conservation of fuel, is published in Bulletin 348 of the University. The study was conducted in cooperation with the National Warm Air Association and the Institute of Boiler and Radiator Manufacturers. The Bulletin appears under the authorship of Seichi Konzo and Warren S. Harris, both of the mechanical engineering staff of the University.

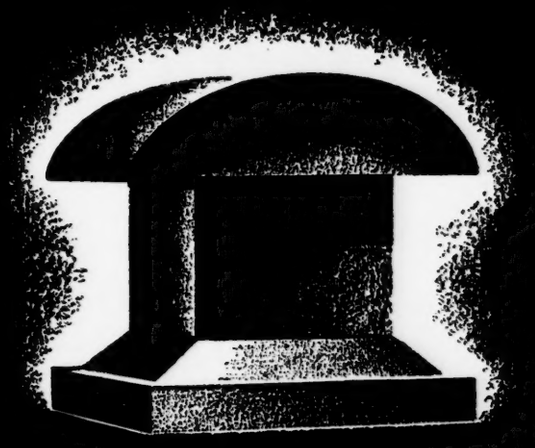
According to abstracts from the Bulletin, studies were made of the fuel savings to be effected by closing of rooms in two insulated houses, in which the heating systems were automatically controlled. One house was heated by means of a gas-fired, forced-air system and the other by means of an oil-fired, forced-circulation, hot-water system. In both houses the windows, including those in bedrooms, remained closed at all times.

When the heat input from the burner greatly exceeded the heat loss from the house and two of the unheated rooms were located directly above the room in which the thermostat was located, no actual saving in fuel consumption was accomplished, even though more than one-third of the living quarters were closed off. On the other hand, when the heat input from the burner corresponded to the heat loss from the house and the unheated rooms were not adjacent to the room in which the thermostat was located, a small saving in fuel consumption was effected by the closing of about one-fourth of the living quarters.

In any case, the actual reduction in fuel consumption was materially less than anticipated reductions based on floor area, room volume, and heat loss, since in computing the anticipated savings no account could be taken, either of the orientation of the unheated rooms with respect to the heated portion of the house, or of the adverse changes that might take place in the operation of the plant as a result of shutting off registers or radiators. Hence, any broad generalization that closing of rooms will result in material reductions in fuel consumption must be regarded with some caution.

In connection with the use of fireplace in the living-room, tests were conducted with and without the use of the fireplace in that room. When the room thermostat was located in the dining room the temperatures

PROBLEM: Moving 8,150,000 cubic feet of air a minute at a large war plant



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Carrier Blackout Ventilators for war plants are available in three types. *Exhaust ventilators* remove hot humid air from plant. *Supply ventilators* replace hot inside air with relatively cooler outdoor air, circulate it uniformly through working areas. *Tempering ventilators* warm the outside air as it is drawn in through the roof. All types are light in weight, require no protective housing or elaborate roof supports. Sturdily constructed of nonferrous panels; conserve critical materials. Keep out rain and snow. Designed for long, trouble-free service. Send now for descriptive literature—Carrier Blackout Ventilators may be the solution to your war plant ventilation problems.

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in all of the rooms, except the living room, were maintained at about 72F. Hence, the open fire in the living room served merely as an adjunct to the main heating plant. With this method of operation the gas consumption for the house was slightly greater than when the fireplace was not used.

When the room thermostat was located in the living room, the localized heating effect in the room by the open fire served to satisfy the demands of the room thermostat, with the result that the temperatures in the remainder of the house dropped several degrees below 72F. Under these conditions, a substantial saving in gas consumption was effected by the fireplace fire. In order to obtain the maximum fuel conservation of the main heating plant with the least disturbance of comfort conditions in the house, the following method of operation is desirable:

(1) Use the fireplace fire in the living room and reduce temperature, either manually or automatically, in all other rooms in the house; (2) Use the fireplace in mild weather in fall, early winter, and spring; (3) Use the fireplace only on relatively calm days; and (4) Close the fireplace damper when the fireplace is not in use, or place a tightly-fitting cover over the front of the fireplace after the fire has died down.

Bulletin consists of 36 pages, paper covered, 6 x 9 in. in size. Individual copies 40c, from the University of Illinois, Urbana, Ill.

BRIEF REVIEWS

GRAPHICAL SOLUTIONS.—The second edition of Professor Mackey's textbook on graphical and mechanical solutions, which includes the fitting of equations to experimental data. The book consists of six chapters covering stationary adjacent scales, sliding scales, network charts, alignment charts, and two chapters on empirical equations. The book is the outgrowth of a course offered in the School of Mechanical Engineering at Cornell. Text is believed to contain material sufficient for a well-rounded course, treatment is elementary, and the mathematics simple. Included is a logarithmic chart for making up scales of any desired size. Title, Graphical Solutions, by Charles Osborn Mackey, Professor of Heat Power Engineering, Cornell University. Size 5½ x 8½, 152 pages, cloth bound, published by John Wiley & Sons, Inc. Price, $2.50.

FACTORY HEATING AND VENTILATING.—A 20-page, 5½ x 8½ in. pamphlet, entitled Ventilation and Heating, Lighting and Seeing. Pamphlet 1 of a series on industrial health and efficiency issued by the Industrial Health Research Board of the Medical Research Council, Great Britain. Information is simple and apparently intended for industrial plant executives to acquaint them with certain fundamental information on factory heating and ventilation. Obtainable from British Information Services, 30 Rockefeller Plaza, New York. Price, 10c.

REFRIGERANTS.—A 6-page reprint of a paper entitled "Sensible Use of Refrigerants Under the Emergency Now Confronting the Industry," by A. C. Buensod and R. W. Waterfill, of Buensod-Stacey, Inc., 60 E. 42nd St., New York, and discussing the effects of the prohibition in the use of Freon-12 in existing systems and the hazards in using substitute refrigerants. The paper was presented before the Society of Motion Picture Engineers in November, 1943.

DUST PROOFING COAL.—A 5-page mimeographed bulletin, standard size, in question and answer form, devoted to the subject of use of fuel oils for the dustless treatment of coal. The booklet is Information Bulletin No. 6 of the Research Laboratories, Battelle Memorial Institute, Columbus, Ohio and is available from the Bituminous Coal Research, Inc., 803 Southern Bldg., Washington, D. C.

INSULATION—a 24-page booklet reproduced from the Bureau of Mines' Information Circular 7263, issued by the Industrial Mineral Wool Institute. Booklet deals with the importance of conserving fuel by reduction of heat loss from industrial equipment. Includes a full description of loose, granulated, blanket, block, board and pipe covering types of mineral wool insulation with examples of equipment and places where each product may be used to obtain best results. Titled "Industrial Insulation with Mineral Products," and available from Industrial Mineral Wool Institute, 441 Lexington Ave., New York 17, N. Y.

CONTROLS—The January, 1944 issue of Consumers' Research Bulletin, published by Consumers' Research, Inc., Washington, N. J., contains a 5-page article on Automatic Heating Controls. Written for the layman and covering residential control only, the article includes a list of a number of control manufacturers.

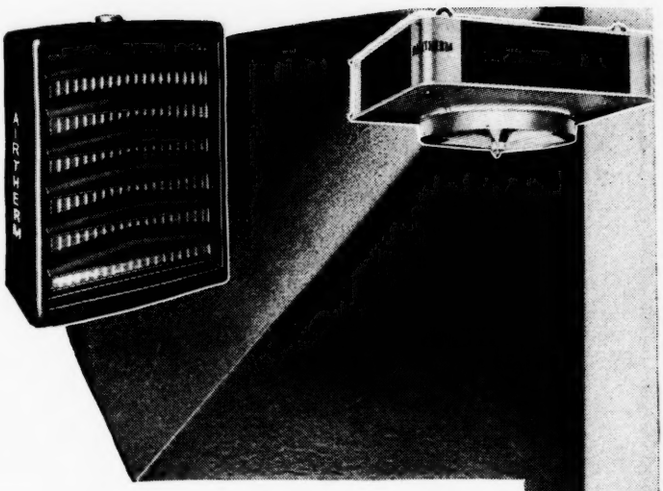
LABORATORIES—The American Council of Commercial Laboratories has issued a standard size, 32-page bulletin listing the 23 laboratory members of the council, together with a tabulation of the type of work handled by each. Copies of the bulletin may be obtained from the executive secretary, A. J. Nydick, 63 Wall St., New York 5, N. Y.

VIBRATION — An introductory book on vibration confined to the basic theories, a number of which are essential to a thorough understanding of the physical phenomena. An entirely new approach to the idea of effective inertia is described in the text and particular emphasis is given to resonance. Title of the book is "Fundamentals of Vibration Study", by R. G. Manley, Vibration Dept., De Havilland Aircraft Company, with a foreword by W. Ker Wilson, D.Sc., Ph.D., Wh.Ex., M.I.Mech.E. Book is cloth bound, 5½ x 8¾ in. Published by John Wiley & Sons, Inc., and Chapman & Hall, Ltd., London. Price, $2.75.

ASBESTOS.—The second edition of The Asbestos Factbook, giving in compact form information on origin, miscellaneous data, locations where found, uses, analysis and qualities of asbestos. Obtainable from Asbestos, 17th Floor, Inquirer Bldg., Philadelphia 30, Pa., for 10c in coin or stamps.

STOKERS — Annual Recapitulation of Stoker Sales which brings up to date statistics and data on stoker sales for 1943 with tabulations and details for previous years. Data are based on U. S. Bureau of Census reports. Mimeographed, 12 pages, available for 15c from the Committee of Ten—Coal and Heating Industries, 307 N. Michigan Ave., Chicago, Ill.

AIRPLANE DUCTS.—An article presenting data for use in design duct systems for supplying air for carburetion, heating, cooling, and ventilating airplanes. Design problems are analyzed both with respect to internal and external expansion of the air stream and combinations of the two. Also presents a formula for determining amount of entry area needed. Sample calculations are carried out on actual examples. Modifications to cover special cases such as addition of heat by radiator are considered. "Essentials of Airplane Duct Design," by Charles A. Mobley, in the January 15, 1944, issue of *Aero Digest*.



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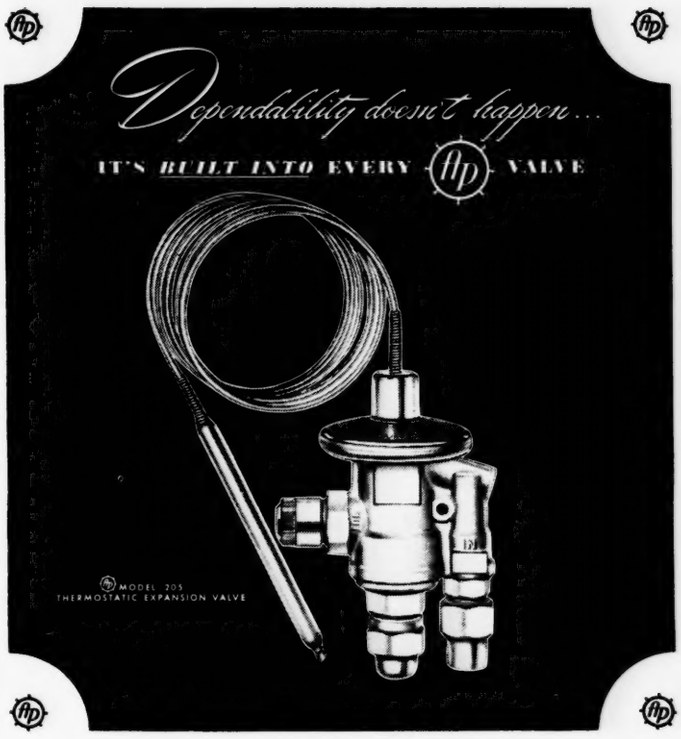

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Degree-Days for February, 1944

HEATING AND VENTILATING'S 16th year of publication of monthly degree-day data

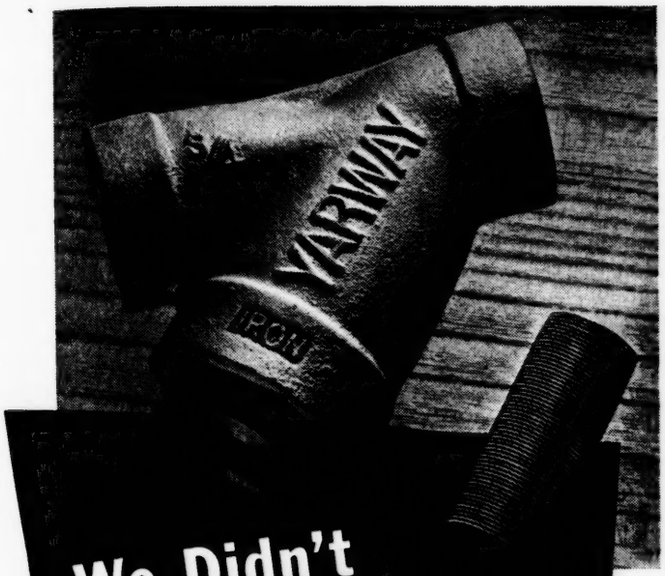
City	Monthly Degree-Days			Cumulative Degree-Days[1]			Year[2]
	Degree-Days, Feb., 1944	Degree-Days, Feb., 1943	Degree-Days, Feb., Normal	Season, 9/1/43-2/29/44	Season, 9/1/42-2/28/43	Season, Normal, 9/1-2/29	Normal, 9/1-6/30
Abilene, Texas	410	332	510	2058	1855	1761	2061
Albany, New York	1203	1144	1142	5200	5311	4868	6580
Albuquerque, New Mexico	727	599	692	3750	2915	3443	4298
Alpena, Michigan	1213	1210	1278	5395	5637	5660	8299*
Anaconda, Montana	1190	1029	1164	5399	5537	5656	8357**
Asheville, North Carolina	624	702	756	3255	3088	3276	4232
Atlanta, Georgia	446	510	557	2329	2219	2370	2890
Atlantic City, New Jersey	840	812	904	3538	3377	3631	5176
Augusta, Georgia	344	399	423	1850	1717	1864	2161
Baker, Oregon	1006	919	991	4761	4909	5024	7163
Baltimore, Maryland	783	732	843	3340	3275	3462	4533
Billings, Montana	1147	909	1120	4543	5160	5254	7119
Binghamton, New York	1126	1069	1182	5093	4900	4965	6808
Birmingham, Alabama	406	444	521	2396	1938	2023	2352
Bismarck, North Dakota	1519	1390	1548	5695	7048	6869	9192
Block Island, Rhode Island	979	940	983	3956	4024	3767	5788
Boise, Idaho	898	815	848	4296	4201	4230	5552
Boston, Massachusetts	1030	967	1042	4301	4362	4322	6045
Bozeman, Montana	1193	1063	1208	5497	5652	5897	8521**
Buffalo, New York	1156	1096	1156	4969	4946	4768	6822
Burlington, Vermont	1402	1245	1294	5857	5847	5496	7514
Butte, Montana	1256	1139	1143	5873	6088	5635	8272
Cairo, Illinois	622	627	762	3131	2968	3169	3909
Canton, New York	1364	1271	1328	5900	6052	5842	8020
Charles City, Iowa	1199	1243	1273	5388	5997	5728	7588
Charleston, South Carolina	286	395	372	1563	1487	1491	1769
Charlotte, North Carolina	522	509	588	2478	2373	2533	3120
Chattanooga, Tennessee	517	552	602	2849	2556	2559	3118
Cheyenne, Wyoming	1102	877	1075	4986	4806	5179	7466
Chicago, Illinois	1044	1042	1083	4641	4946	4276	5957
Cincinnati, Ohio	786	824	862	3758	3759	3675	4684
Cleveland, Ohio	983	964	1075	4323	4317	4441	6155
Columbia, Missouri	835	746	897	3939	3808	3963	4922
Columbia, South Carolina	377	429	498	1997	1863	2000	2364
Columbus, Ohio	864	897	980	4026	4018	4113	5398
Concord, New Hampshire	1285	1189	1240	5541	5564	5321	7353
Concordia, Kansas	897	770	970	4053	4168	4173	5315
Dallas, Texas	382	346	493	2014	1825	1980	2256
Davenport, Iowa	1047	1025	1140	4538	4948	4825	6289
Dayton, Ohio	923	865	980	4323	3991	4043	5264
Denver, Colorado	921	682	918	3976	3720	4273	5874
Des Moines, Iowa	1048	998	1173	4665	4989	4935	6384
Detroit, Michigan	1053	1034	1134	4702	4869	4718	6490
Devils Lake, North Dakota	1652	1516	1551	6499	7605	7371	9970
Dodge City, Kansas	842	667	890	4077	3645	3958	5035
Dubuque, Iowa	1109	1122	1218	4897	5373	5194	6790
Duluth, Minnesota	1468	1409	1464	6376	6905	6680	9443
Eastport, Maine	1286	1135	1232	5453	5539	5502	8520**
Elkins, West Virginia	852	925	991	4392	4008	4256	5697
El Paso, Texas	452	389	434	2351	1857	2101	2428
Ely, Nevada	1217	1013	—	5428	5091	—	—
Erie, Pennsylvania	1051	1028	1098	4527	4483	4434	6273
Escanaba, Michigan	1268	1307	1340	5653	6059	6028	8771*
Evansville, Indiana	750	756	854	3688	3596	3348	4244
Fort Smith, Arkansas	512	469	630	2614	2417	2657	3147
Fort Wayne, Indiana	1047	1027	1098	4817	4873	4503	5925
Fort Worth, Texas	390	339	498	1971	1821	1904	2148
Fresno, California	475	376	389	2008	2074	1883	2334
Galveston, Texas	136	169	255	1028	836	938	1016
Grand Junction, Colorado	871	733	863	4034	3710	4374	5548
Grand Rapids, Michigan	1057	1053	1204	4716	4893	4863	6535
Green Bay, Wisconsin	1217	1266	1358	5453	5879	5778	7825
Greensboro, North Carolina	673	636	678	3163	2929	2845	3529
Greenville, South Carolina	510	543	661	2496	2394	2739	3380
Harrisburg, Pennsylvania	930	880	1008	4107	3987	4077	5375
Hartford, Connecticut	1063	1037	1100	4638	4640	4416	6036
Hatteras, North Carolina	462	504	535	2123	1834	1851	2571
Havre, Montana	1231	1101	1450	5096	6249	6388	8700
Helena, Montana	1213	1216	1178	5536	6057	5611	7898
Houston, Texas	164	159	277	1145	984	1092	1157
Huron, South Dakota	1445	1167	1340	5605	6268	6075	8004
Indianapolis, Indiana	877	932	969	4048	4194	4099	5298
Kansas City, Missouri	847	738	946	3855	3838	3953	4956
Kewanee, Illinois	1054	1079	1106	4813	5170	4640	6139
Knoxville, Tennessee	548	640	666	2928	2810	2964	3670
La Crosse, Wisconsin	1325	1222	1265	5575	5913	5578	7322
Lander, Wyoming	1410	943	1155	6115	5350	5666	7947

[1]Cumulative data identical with monthly figures for September only. In subsequent months, cumulative figures will show record for whole heating season to and including month in question.

[2]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with eight exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, and Sioux City, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; J. M. Hartman, Engineering Department, Kewanee Boiler Corp., Kewanee, Ill., and Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, respectively; Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

[Table concluded on page 98]



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Degree-Days for February, 1944 (Concluded)

HEATING AND VENTILATING'S 16th year of publication of monthly degree-day data

City	Monthly Degree-Days			Cumulative Degree-Days[1]			Year[2]
	Degree-Days, Feb., 1944	Degree-Days, Feb., 1943	Degree-Days, Feb., Normal	Season, 9/1/43-2/29/44	Season, 9/1/42-2/28/43	Season, Normal, 9/1-2/29	Normal, 9/1-6/30
Lansing, Michigan	1152	1107	1201	5187	5266	5202	7048
Lewiston, Maine	1330	1209	1243	5891	5647	5532	7707
Lincoln, Nebraska	1020	852	1131	4351	4582	4643	5999
Little Rock, Arkansas	472	459	582	2526	2364	2380	2811
Livingston, Montana	1113	900	1067	4703	5083	5018	7205
Los Angeles, California	329	174	266	946	757	1016	1504
Louisville, Kentucky	687	726	801	3352	3380	3327	4180
Lynchburg, Virginia	681	663	730	3033	2943	3143	3980
Macon, Georgia	345	428	462	1969	1766	1908	2201
Madison, Wisconsin	1177	1207	1299	5254	5701	5557	7429
Marquette, Michigan	1266	1266	1361	5591	5989	5915	8693*
Memphis, Tennessee	463	522	599	2616	2429	2470	2950
Meridian, Mississippi	320	391	456	1993	1742	1891	2160
Milwaukee, Wisconsin	1145	1178	1201	5160	5482	5185	7245
Minneapolis, Minnesota	1290	1333	1400	5553	6322	5950	7850
Modena, Utah	1053	863	905	4753	4340	4764	6562
Montgomery, Alabama	280	371	392	1732	1532	1676	1884
Nantucket, Massachusetts	982	946	974	3949	4021	3912	5957
Nashville, Tennessee	537	609	675	2922	2760	2850	3507
New Haven, Connecticut	1042	952	1011	4423	4249	4230	5895
New Orleans, Louisiana	115	235	230	1092	974	965	1024
New York, New York	936	864	960	3890	3766	3869	5347
*Nome, Alaska	1855	2081	1990	6760	7566	7226	14580**
Norfolk, Virginia	628	572	650	2641	2344	2583	3350
North Head, Washington	604	513	622	2775	3023	3132	5452**
North Platte, Nebraska	1114	788	1020	4577	4424	4806	6366
Oakland, California	447	345	403	1929	1941	2029	3143**
Oklahoma City, Oklahoma	592	517	742	2832	2734	2986	3613
Omaha, Nebraska	1068	909	1126	4619	4790	4765	6131
Oswego, New York	1158	1097	1162	5033	5021	4933	7088
Parkersburg, West Virginia	786	812	879	3861	3624	3701	4775
Peoria, Illinois	1031	967	1067	4656	4698	4673	6109
Philadelphia, Pennsylvania	853	817	893	3583	3579	3629	4855
Phoenix, Arizona	355	161	263	1248	895	1253	1405
Pittsburgh, Pennsylvania	894	871	944	4048	3859	3947	5235
Pocatello, Idaho	1094	952	986	5080	4680	4853	6655
Portland, Maine	1273	1178	1162	5524	5507	5088	7218
Portland, Oregon	606	527	644	2852	2943	3174	4469
Providence, Rhode Island	1004	942	1070	4213	4261	4316	6015
Pueblo, Colorado	899	693	916	4352	3787	4140	5514
Raleigh, North Carolina	583	540	630	2715	2467	2605	3234
Rapid City, South Dakota	1270	907	1119	4966	5279	5140	7118
Reading, Pennsylvania	916	881	980	3954	3920	4082	5389
Redding, California	509	353	418	1974	1947	1951	2451
Reno, Nevada	868	700	823	4216	3779	4149	5892
Richmond, Virginia	687	640	695	3039	2856	2906	3695
Rochester, New York	1192	1081	1159	5086	5035	4825	6732
Roseburg, Oregon	615	485	605	2912	2718	3090	4428
Roswell, New Mexico	563	469	580	2950	2371	2876	3484
Sacramento, California	462	377	426	1957	1956	2036	2653
St. Joseph, Missouri	907	790	974	4091	4153	4121	5161
St. Louis, Missouri	778	701	854	3545	3510	3652	4585
Salt Lake City, Utah	941	878	885	4516	4142	4144	5555
San Antonio, Texas	252	192	274	1468	1159	1128	1202
San Diego, California	303	163	280	929	803	1099	1645
Sandusky, Ohio	982	979	1061	4352	4462	4384	6208
San Francisco, California	386	286	356	1559	1650	1770	3264**
Sault Ste. Marie, Michigan	1397	1365	1487	6121	4974	6315	9285**
Savannah, Georgia	222	313	316	1313	1234	1323	1490
Scranton, Pennsylvania	1055	1025	1106	4675	4598	4552	6129
Seattle, Washington	614	553	647	2852	3066	3297	4934**
Sheridan, Wyoming	1259	905	1160	5170	5167	5789	8008
Shreveport, Louisiana	309	328	412	1908	1682	1736	1938
Sioux City, Iowa	1204	1010	1260	5096	5459	5278	6898
Spokane, Washington	942	889	952	4514	4713	4707	6355
Springfield, Illinois	899	829	1008	4095	4145	4191	5373
Springfield, Missouri	748	687	876	3669	3459	3523	4428
Syracuse, New York	1176	1105	1212	5173	5125	4980	6893
Tacoma, Washington	655	602	675	3182	3287	3438	5181**
Terre Haute, Indiana	859	814	966	3953	3944	3876	4872
Toledo, Ohio	1069	1023	1075	4792	4727	4467	6077
Topeka, Kansas	829	728	935	3807	3855	3953	4969
Trenton, New Jersey	906	872	941	3949	3876	3715	4933
Utica, New York	1260	1061	1181	5513	5299	4966	6796
Valentine, Nebraska	1268	920	1130	5109	5209	5225	7039
Walla Walla, Washington	770	732	778	3814	3722	3676	4808
Washington, D. C.	778	732	848	3411	3279	3559	4626
Wichita, Kansas	762	690	896	3551	3654	3773	4673
Williston, North Dakota	1419	1361	1495	5717	6997	6958	9323
Winnemucca, Nevada	964	723	905	4539	4047	4644	6427**
Yakima, Washington	820	779	846	4116	4389	4433	5599

*Includes August. **Includes July and August. (a) Data not yet available.

[1]Cumulative data identical with monthly figures for September only. In subsequent months, cumulative figures will show record for whole heating season to and including month in question.

[2]Figures in this column are normal totals for a complete heating season, September to June, incl.

ANY REFRIGERATION USER CAN

1. INCREASE REFRIGERATION CAPACITY
2. SAVE UP TO 35% OF POWER
3. SAVE CONDENSER WATER COST BY INSTALLING A

NIAGARA *Duo-Pass* AERO CONDENSER

Evaporative condensing with the NIAGARA Duo-Pass lowers condensing temperatures and reduces head pressures. Users have found that power savings as high as 35% have resulted at the same time that refrigeration capacity was increased. By reducing the condensing temperature, the NIAGARA Duo-Pass also prevents the deposit of scale on condenser tubes—holds the efficiency of the condenser constant and makes these savings permanent.

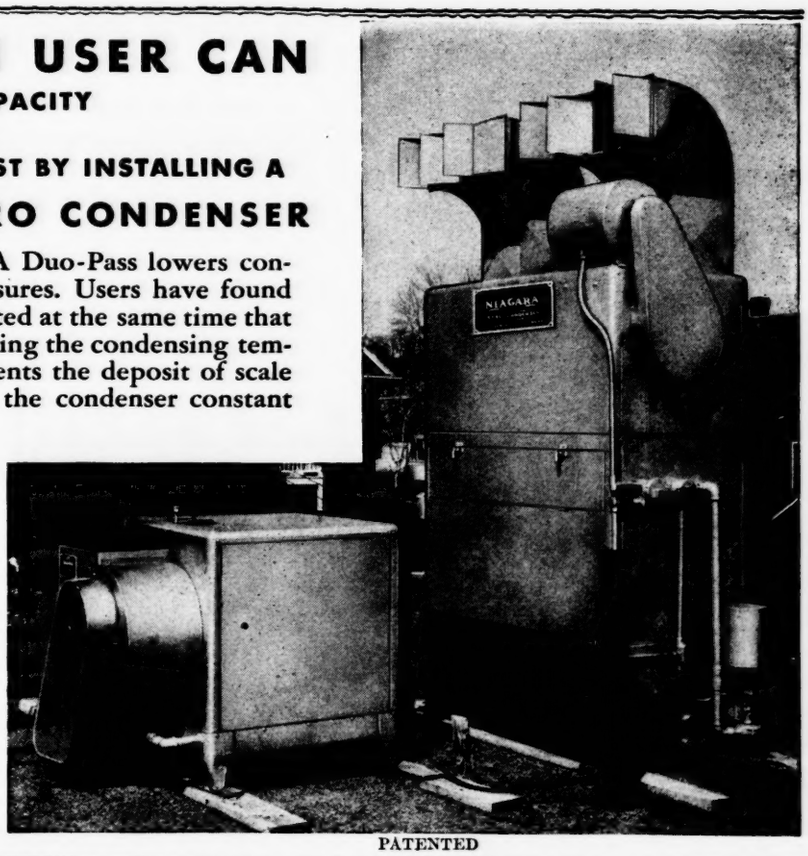
By the use of atmospheric air to take up the heat of condensation, 95% of condenser water is saved. As it replaces both cooling tower and shell-and-tube condenser, the NIAGARA AERO CONDENSER is inexpensive to install and offers refrigeration users the simplest and most practical way to increase capacity and cut costs.

Write for Bulletins 91 and 93

NIAGARA BLOWER COMPANY

"25 Years of Service in Air Engineering"

NEW YORK ADDRESS: Dept. HV-44
6 E. 45th Street, New York 17, N. Y.
Field Engineering Offices in Principal Cities



PATENTED

NIAGARA INDUSTRIAL COOLING • HEATING • DRYING HUMIDIFYING • AIR ENGINEERING EQUIPMENT

Do You Realize . . .

- THAT EVEN A SHORT PIECE OF PIPE WILL EXPAND WITH AN INCREASE IN TEMPERATURE?
- THAT IF THERE IS A "STIFF" CONNECTION, THE STRESSES SET UP WILL BE TREMENDOUS?
- THAT YOU MUST PROVIDE FOR THE EXPANSION?

Don't assume, because the pipe is short, there is no need to worry about expansion. This may be true if the arrangement of the piping is such that the expansion can be taken care of by a spring connection without unduly stressing it. But, often the piping is "stiff" and then expansion stresses may be introduced which are greater than the pipe or fittings can withstand.

Don't take this chance. Install ADSCO Internally Guided Expansion Joints. Write for illustrated bulletin No. 35-30 HV.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, N.Y.
MAKERS OF "UP-TO-DATE" STEAM LINE EQUIPMENT FOR OVER 60 YEARS

ADSCO Internally Guided Joint in blow-down line from boiler.

ADSCO EXPANSION JOINTS
Eliminates cumbersome pipe bends

DE-STA-CO Blower Wheel Housings

of Standard Dimensions

Made in sizes to fit 4½, 5, 6, 7½ and 9 inch wheels and in widths to suit single or double inlet wheels . . . also individual parts for your own assembly.

De-Sta-Co housings are engineered for maximum efficiency and quietness in operation . . . neatly finished. Send for "De-Sta-Co Blower Housings" bulletin; gives complete information, including essential dimensions.

DETROIT STAMPING CO.
Established Over 25 Years
375 Midland Ave • Detroit 3, Mich.

UNIT HEATERS

Carrier Corp., Syracuse 1, N. Y.

Three standard size folders as follows: Carrier 46S Unit Heaters Insure Wide Heating Coverage and Flexibility, points out that this unit saves critical materials; Economical Heating for Industrial Buildings, two-page sheet, describes the type 46E unit heater with propeller fan for horizontal discharge. Sheet shows charts of (1) dimensions of various sizes of this unit, (2) steam ratings, and (3) Btu constants; Carrier Blower-Type Heat Diffusers, four-page folder, describes advantages of four models of these diffusers in heating and ventilating large areas. Folder includes charts of Btu constants, steam ratings, and dimension drawings of horizontal suspended units, vertical suspended units, and floor-mounted units.

SPRAY NOZZLES

Spraying Systems Co., 4031 W. Lake St., Chicago 24, Ill.

Designed as an engineering guide to the selection of the right spray nozzle for any purpose, a 32-page standard-size catalog No. 22 is available to users of spray nozzles and related equipment. Catalog details spray characteristics, dimensions and performance data on the company's complete line of standard spray nozzles. Also described are special purpose nozzles, made of a variety of materials, as well as accessories such as strainers and adjustable joints. Nozzles are fully illustrated to show construction and kind of spray pattern produced. Written specifications on each nozzle are supplemented by tables showing capacities in gallons per minute and spray angles at various pressures for all the types and sizes available.

Also carried in the catalog are descriptions of humidifying assemblies, roof spraying systems, and cooling tower and spray pond assemblies. Several tables of engineering data complete the book.

BELT DRIVES

The American Pulley Company, 4200 Wissahickon Ave., Philadelphia 29, Pa.

An automatic belt tension control feature termed Econ-o-matic Drive is described in this 70-page handbook. In addition, information is presented on V-belt and Flat-belt drive selection, specifications, and instructions regarding installations.

SLIDE AND BUTTERFLY VALVES

W. S. Rockwell Co., 50 Church St., New York 7, N. Y.

A standard size, loose-leaf-punched, 24-page catalog No. 406, devoted to the company's line of slide and butterfly valves of various types, and giving dimensional data, drawings, and other information in complete and attractive form.

AIRCRAFT HEATING

Surface Combustion, Toledo, Ohio.

A standard size, 4 color, 8-page folder devoted to the company's Janitrol aircraft heaters.

MOTORS

Century Electric Co., 1806 Pine St., St. Louis 3, Mo.

A standard size, loose-leaf-punched, 12-page catalog, devoted to the company's line of direct-current motors.

ELECTRONIC TUBES

General Electric Co., Schenectady, N. Y.

A quick-selection chart of electronic tubes for industry is contained in a new 4-page bulletin ET-12.

MOTORS

General Electric Co., Schenectady, N. Y.

Low-speed synchronous motors and control for compressor drives are featured in a 4-page bulletin, GEA-4139. This well illustrated publication describes the application of low-speed synchronous motors, emphasizing the necessity of providing in the installation the proper amount of flywheel effect to avoid excessive current pulsations; lists the most important construction features, especially in respect to the rotors and stators; and discusses the synchronization, field removal, and motor protection afforded by the G-E synchronous motor control.

NEW PRODUCTS CHECK CHART

Designers For Industry, Inc., 2915 Detroit, Ave., Cleveland 13, Ohio.

A 4-page mimeographed checklist developed around a list of 46 questions to provide a systematic plan whereby a manufacturer can quickly appraise a product which he believes might be a desirable one for his company to make. Chart also serves as an outline for a deliberate and detailed study of the principal factors involved. Available without charge from Designers For Industry, Inc., 2915 Detroit Ave., Cleveland 13, Ohio.

COMBUSTION CONTROLS

Leeds & Northrup Co., 4911 Stenton Ave., Philadelphia, Pa.

A standard size, 36-page catalog N-01M-163 entitled Metermax Combustion Control For Boiler Furnaces, presenting in photographic form illustrations of various features of design. Of particular interest to those in central station or large industrial power plants.

FIRE CLAY BRICK

McLeod & Henry Co., Inc., Troy, N. Y.

A 4-page standard size bulletin devoted to the company's three new fire bricks—Hyex, Super-Hyex, and Superam.

COMING EVENTS

APRIL 27-28—Annual Convention of the Sheet Metal Contractors' National Association, Inc., to be held at the Hotel La Salle, Chicago. Full details obtainable from Rudy Guenther, Chicago member of the Board of Directors of the National Association.

MAY 31-JUNE 2—The Fifty-fifth Annual Convention of the Heating, Piping and Air Conditioning Contractors National Association, to be held at the Hotel Statler, Cleveland.

JUNE 5-7—The 31st Spring Meeting of The American Society of Refrigerating Engineers, to be held at the William Penn Hotel, Pittsburgh.

JUNE 7-8—Mid-Year Meeting of the National Warm Air Heating and Air Conditioning Association, to be held at the Stevens Hotel, Chicago. T. Reid Mackin, International Heater Co., is chairman of the Chicago convention committee.

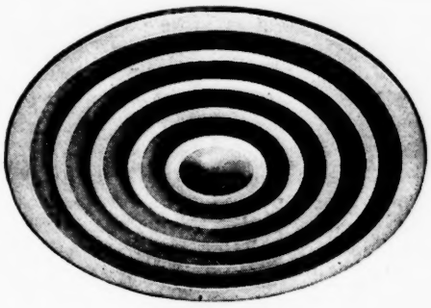
JUNE 19-20—Summer Convention of the American Society of Heating and Ventilating Engineers, to be held at the Pantlind Hotel, Grand Rapids, Mich.

NOVEMBER 15-19—Third National Chemical Exposition will be held at the Chicago Coliseum, Chicago, Ill. Sponsored by Chicago Section of the American Chemical Society. Headquarters for the show at 330 So. Wells Street, Chicago 6, Ill.

AEROFUSE OUTLET

•1•

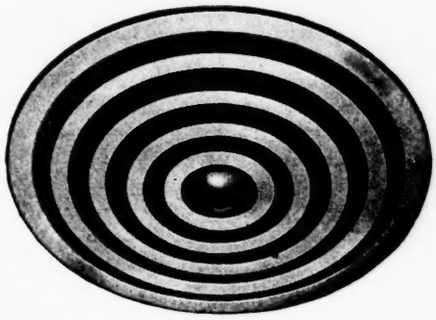
MAXIMUM AIR MIXTURE



TYPE S1

•2•

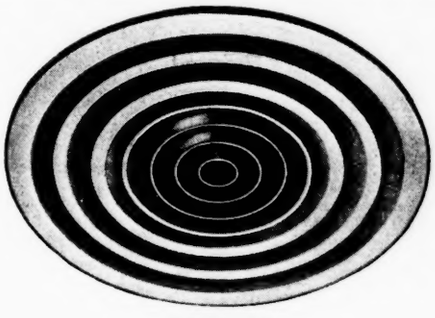
RAPID TEMPERATURE EQUALIZATION



TYPE E

•3•

PERFECT AIR DISTRIBUTION



TYPE R1

•4•

TOTAL ELIMINATION OF DRAFTS

Send for Catalog and Engineering Data

TUTTLE & BAILEY, INC.
NEW BRITAIN, CONN.

FREON SHELL and TUBE CONDENSERS

Cleanable

WITHOUT BREAKING WATER CONNECTIONS

● The efficient operation of Acme shell and tube condensers for Freon and methyl chloride has long been recognized throughout the industry. Shells of seamless steel tubing eliminate possibility of leaks that could occur in welded shells. "All-in-one" finned tubing, one piece of metal, assures maximum heat transfer efficiency. Removable heads make them cleanable. Tubes are replaceable. STANDARD model capacities up to 120 tons—SENIOR models up to 460 tons.

On SENIOR models the heads are "through bolted" to the tube sheets and are cleanable without breaking water connections. Write for complete information—Catalog No. 23.

● Acme shell and coil condensers supply excellent service where available water condition is satisfactory for their application. Shells of seamless steel tubing closed and sealed on both ends. Copper condenser coil. Sizes up to 8 tons. Write for Catalog No. 24.

ACME PRODUCTS

ACME PRODUCTS

Evaporative Condensers	Forced Convection Units
Ammonia Condensers	Pipe Coils
Freon Condensers	Heat Interchangers
Dry-Ex Water Coolers	Oil Separators
Flooded Water Coolers	Liquid Receivers
Hi-Peak Water Coolers	Heat Exchangers

Write for Catalog on any item.

ACME INDUSTRIES
JACKSON, MICHIGAN

PERSONALS AND PERSONNEL

T. C. KNUDSEN

has been named manager and chief engineer of the new Texrope department established by Allis-Chalmers Mfg. Co., Milwaukee, Wis. Mr. Knudsen has been closely associated with the Texrope drive from its inception and played a major part in its development. He entered the employ of Allis-Chalmers in 1922, as a member of the milling machinery department.

R. P. EXTEN

has joined Young Radiator Co., Racine, Wis., as executive assistant to the president, according to an announcement by Fred M. Young, president. Mr. Exten received his early training in the automotive and accessories fields serving in various capacities with Studebaker, Timken-Detroit Axle and Hudson. He was more recently associated with Climax Engineering Co., Clinton, Iowa, as chief draftsman and assistant engineer and the Mechanics Universal Joint and Rockford Drilling Machine Divisions of the Borg-Warner Corporation, Rockford, Illinois, as production engineer. In his new position he will devote himself particularly to production matters.

E. K. ECKERT

a lieutenant in the USNR, now on the inactive list, and a mechanical engineer, has opened offices at 700 Wolverine Building, S. 4th Ave. and E. Washington St., Ann Arbor, Mich. Together with associates he will specialize in technical writing and allied engineering.

LYMAN D. WARNER

has been appointed sales manager of the Crocker-Wheeler Div. Joshua Hendy Iron Works, Ampere, N. J. Mr. Warner was assistant sales manager since 1941 and active in the sale of motors, generators, and flexible couplings for Crocker-Wheeler since 1937. Prior to that he was associated with the Ingersoll-Rand and General Electric.

FRED T. GOES

was elected on February 15 president of the Vilter Mfg. Co., Milwaukee, being advanced from his former position of vice-president which he had held since 1938. William B. Vilter was appointed a member of the board to fill the vacancy caused by the death of his father, the late Wm. O. Vilter who died January 31.

Fred T. Goes

Mr. Goes started his career with Vilter in 1915 and filled successively the positions of estimator, sales engineer, plant engineer, comptroller, secretary and vice president and works manager.

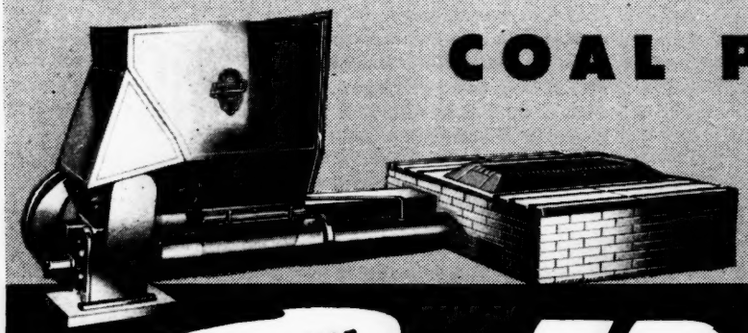
Mr. Vilter, who has been associated with the company since 1934, was elected Vice-President to succeed Mr. Goes and will continue as director of personnel.

I. G. BOHRMAN

who has directed radiator sales for Perfex Corporation, Milwaukee, has been appointed manager of the Radiator Division. Mr. Bohrman takes over his broader duties in connection with expansion of Perfex radiator facilities, which will shortly occupy additional plant area now under construction. This is the fourth addition to the plant in three years, and will increase the present floor area by fifteen per cent.

He formerly served in engineering capacities with Hercules Motors Corporation and Waukesha Motors Company, and has been active in the field for eighteen years.

STOKERS NOW APPROVED FOR INSTALLATION IN HAND-FIRED PLANTS BURNING 25 TONS OF COAL PER YEAR...!



This opens up thousands of new stoker prospects, and means a greater-than-ever sales opportunity for *you!* Join forces with Freeman in the national fuel conservation program. Make real profits selling these apartment-commercial-industrial jobs *now* . . . get set for the day when production limitations are removed. Write or wire about *your* territory!

A PIONEER OF THE STOKER INDUSTRY . . . AND ONE OF THE LEADERS *in National Sales Volume*

FREEMAN STOKERS

FIRST CHOICE OF AMERICA'S FOREMOST HEATING ENGINEERS

FREEMAN STOKER DIVISION, ILLINOIS IRON & BOLT CO., 918 SO. MICHIGAN AVE., CHICAGO 5, ILL.

ACME INDUSTRIES, INC.

Jackson, Mich., announces that George Bingham, a former newspaper man, has been appointed personnel manager. Joseph T. Maloney has joined the company as sales engineer. Mr. Maloney was formerly in the Cincinnati office of Fairbanks Morse & Company.

KARL SCHICK

has been appointed sales manager of the newly formed railway controls division of the Minneapolis-Honeywell Regulator Company. Mr. Schick has been Chicago zone supervisor of the company's air conditioning controls division and has been working closely on railroad control problems, particularly with regard to journal box warning systems and heating controls for the past two years. James Locke of the Chicago zone has been elevated to Mr. Schick's former position. Mr. Locke recently has been supervising the design and installation of automatic control systems for aircraft engine test calls. Appointed as assistants to Mr. Schick are George Badger and Alan Buckley, both of whom have been working on railroad control problems since the war began.

CLIFF S. WHITE

has been appointed district representative for Airtemp Division, Chrysler Corp. Following preliminary training in Dayton, Mr. White will take up an assignment in the Cincinnati territory. Mr. White's experience in the refrigeration industry was gained through an association with C. V. Hill & Co., commercial refrigerator manufacturer, over an 11-year period. In 1940, Mr. White was appointed divisional manager of the Hill company's central division, with headquarters in Cincinnati, where he has resided since that time.

S. E. LAUER

president of the York Corporation, York, Pa., has been appointed a member of the Philadelphia Regional War Labor Board, Region III, as a representative of industry.

SIDNEY H. WEBSTER

former advertising and technical data director for Eclipse Aviation Products, Teterboro, N. J., has been appointed Pacific coast sales and engineering representative. Mr. Webster will make his headquarters in the Los Angeles office of the Eclipse-Pioneer division.

HENRY E. HERMANN

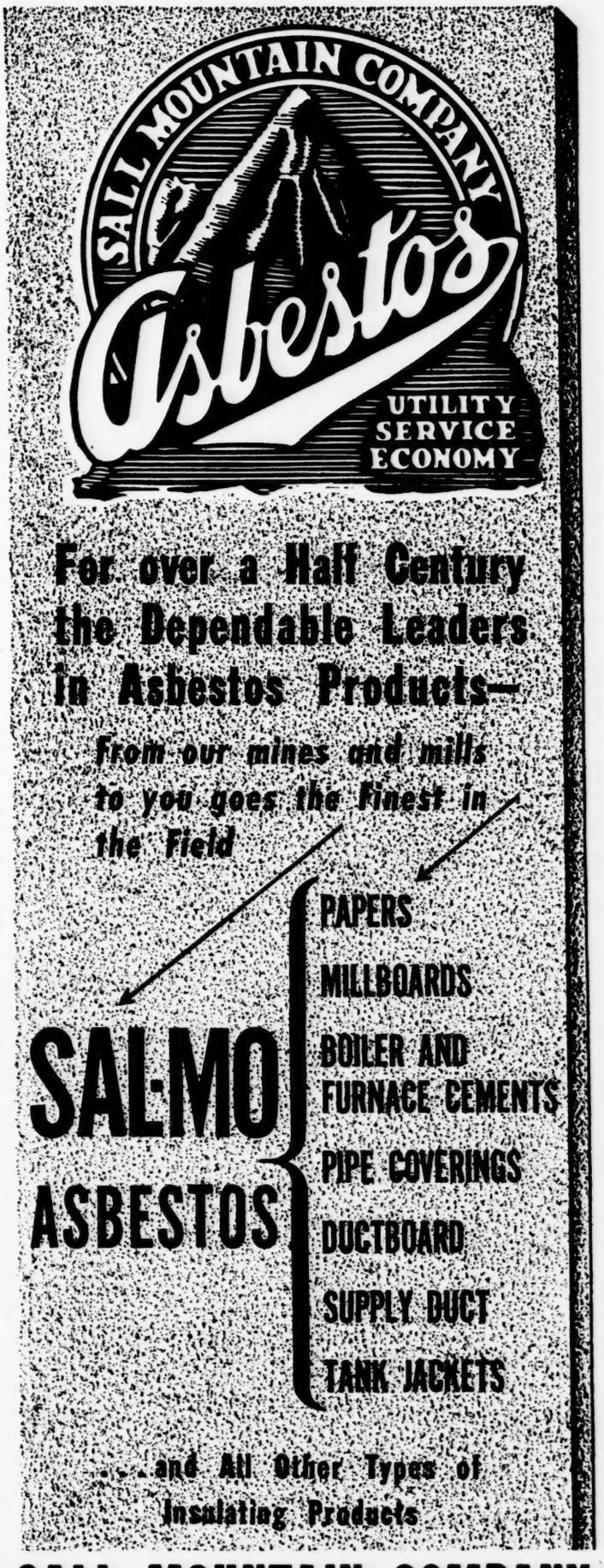
has been appointed works manager of the Bear Mfg. Co., Rock Island, Ill., in charge of all production. Mr. Hermann has had a long career of plant supervision serving in various capacities with the John Deere Spreader Works in Moline and Welland, Ontario, Canada, and in the Deere Tractor Works in Waterloo, Iowa. For the past several years he has been plant engineer of the John Deere Plow Works in Moline. L. B. Arp, who has served as production manager in addition to handling purchasing and personnel, will hereafter devote his entire time to his duties as director of purchases and of personnel.

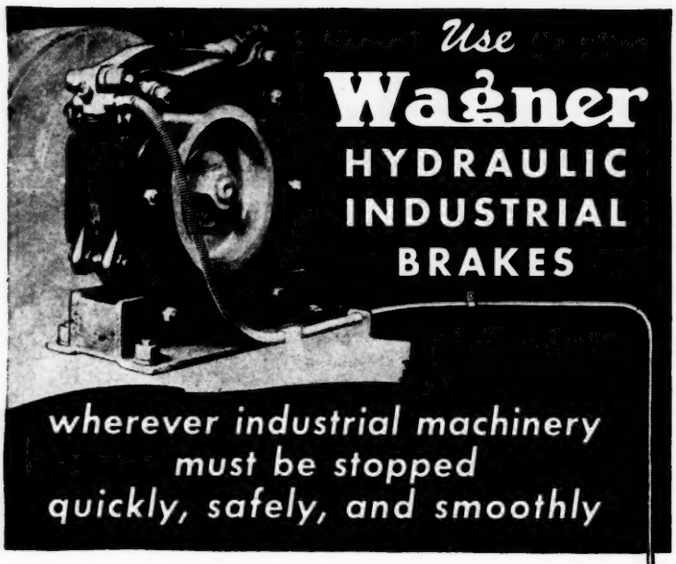
E. B. SCOTT

has been appointed sales manager of the Engine Division, Enterprise Engine & Foundry Co., largest builders of Diesel engines in the West. Prior to his promotion, Mr. Scott was manager of the repair and maintenance division, and assistant to the vice-president, C. G. Cox.

SPENCER JONES

consulting engineer, has opened a new and more conveniently located office at 122 East 42nd St., New York 17, N. Y., from which he will continue to provide counsel and copy in technical advertising for manufacturers and advertising agencies.





Use
Wagner
HYDRAULIC
INDUSTRIAL
BRAKES

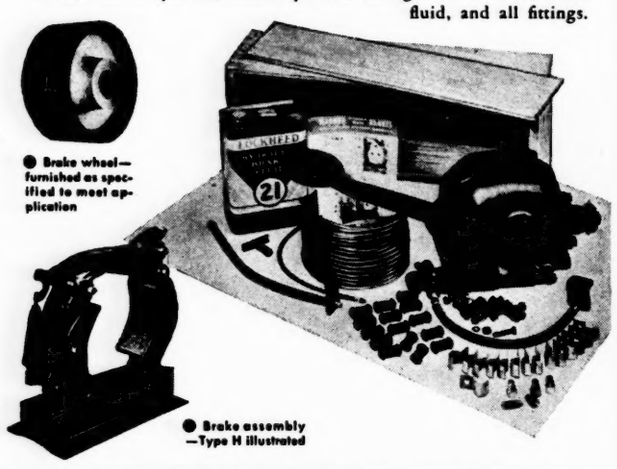
wherever industrial machinery
must be stopped
quickly, safely, and smoothly

While the principal application for Wagner hydraulic industrial brakes is for overhead traveling cranes, there are many other applications for which they can be efficiently used.

Some of these applications are bending rolls, scrap balers, large wheel balancers, and similiar applications when it is desirable to decelerate the machine by foot pressure for either normal or emergency stops.

Available in Complete Systems

Wagner hydraulic industrial brakes come to you complete, all ready to install. The complete system includes brake assembly, brake wheel, master cylinder, wheel cylinder, tubing, flexible hose, brake fluid, and all fittings.



● Brake wheel—furnished as specified to meet application

● Brake assembly —Type H illustrated

REPLACEMENT BRAKE LINING
For any industrial brake

● Non-scoring

● Reinforced wire backing permits deep seating of bolts or rivets

Wagner molded brake lining is preformed in blocks to meet the requirements for all industrial brakes.

Send for Bulletins IU-20 *and* BU-145

144-7

Wagner Electric Corporation
ESTABLISHED 1891
6463 Plymouth Avenue, St. Louis 14, Mo., U. S. A.
ELECTRICAL AND AUTOMOTIVE PRODUCTS

G. BRONSON PHILHOWER

has recently been added to the staff of the New York office of Tube Turns, Incorporated, to represent the firm in the metropolitan New York area and New England. Mr. Philhower, who was a naval engineer in World War I, has for years been connected with eastern pipe fabricators and distributors, and has had experience covering the field from mill apprentice to district sales manager.

JOHN H. BENNETT

formerly with Kelvinator Export Division, has joined Universal Cooler Corporation, Marion, Ohio, as field engineer. His appointment is effective immediately. Mr. Bennett now is supervising field tests on Universal Cooler Units built for the armed forces. After the war, he will assume special duties in connection with the engineering of the company's refrigerating units.

MALCOLM LUND

who recently served as campaigns manager on national conservation programs for WPB and OPA in Washington, is now handling war fuel conservation work with Perfex Corporation, Milwaukee. Mr. Lund was formerly advertising manager for the Parker Pen Company and account executive with Chicago advertising agencies.

I. M. REMEN

has been appointed manager of Montgomery Ward & Co.'s Plumbing and Heating Division. Mr. Remen was engaged in the manufacture and sale of plumbing and heating equipment in Chicago for the last twenty years. He joined the Ward organization about 18 months ago as regional supervisor of plumbing and heating in Ward's retail stores in the Chicago district.

WITH THE MANUFACTURERS

THE CLEVELAND HUMIDIFIER CO.

headed by Harold S. Sharp, president, has been organized as an Ohio corporation with temporary headquarters at 7802 Wade Park Ave., Cleveland 3, and has acquired manufacturing and sales rights on Monmouth Humidifiers formerly made by Monmouth Products Co. of Cleveland.

AIRTEMP DIV. CHRYSLER CORP.

has announced the appointment of Jamison Engineering Company as its dealer in the Dayton area. The new organization is headed by M. M. Jamison who has purchased all assets of Bard Incorporated. Mr. Jamison reports that personnel of the dealership will be retained intact with Phil Brobston continuing as office manager, W. K. Jamison as chief engincer and Art Senzer as service manager. Twenty-four-hour service will be maintained on all Airtemp products, and on stokers, ventilating equipment, and special lines handled by the organization.

GENERAL CONTROLS CO.

has opened a new branch office at 376 Nelson St., S.W., Atlanta 3, Ga., under the direction of branch manager Roger W. Allen.

UNITED STATES RADIATOR CORP.

announces that H. B. Clark, of White, Weld & Co., New York, has been elected a director.

CONDENSATION ENGINEERING CORP.

has moved to 122 S. Michigan Ave., Peoples Gas Building, rooms 849-851, Chicago, Ill.

R. VOIGT & SON CO.

1060 Military Road, Buffalo, N. Y., with a plant of 10,000 sq ft floor space, equipped for steel fabrication, wood working, and hydraulic equipment assembly, is looking for negotiations on a post-war proposition whereby the company would take a product idea from scratch and handle research, design, manufacturing and merchandising or just designing and merchandising. The company has a prospectus entitled A Post-War Proposal, available for those interested.

BLOCKER CORPORATION

is the new name of the Blocker Air Conditioning Corporation, 33 Clay St., Newark, N. J. The change in name involves no change in corporate structure or personnel.

COCHRANE CORPORATION

Philadelphia, announces the acquisition of exclusive sales rights to the line of Rotameters manufactured and hitherto sold by Rotameters, Inc., Jenkintown, Pa. No change will be made in the personnel of the two companies.

C. J. TAGLIABUE MFG. CO.

Brooklyn, N. Y., has elected A. F. Rucks president and general manager. He succeeds the late C. D. Waters. Mr. Rucks has been associated with the company for over thirty years, during which time he has held a number of important positions in the organization. J. T. Kottcamp, vice-president of the Johns-Manville Products Corporation, has been elected to the board of directors of the company.

KINETIC CHEMICALS, INC.

is building a new plant for the manufacture of Freon-12 fluorine refrigerant at East Chicago, Ind. The plant is being built on property of the Grasselli Chemicals Department of the Du Pont Company, and the equipment going into it is being leased from the Defense Plant Corporation. The East Chicago plant will have a capacity of approximately 2,000,000 lb of Freon per month, and is in addition to a new plant at Deepwater Point, N. J., which is shortly to come into operation.

WAILES DOVE-HERMISTON CORPORATION

Westfield, N. J., is constructing a new plant at Houston, Texas, to supply bitumastic enamels and pipe coatings in the southwest. The new plant is located at 7002 Clinton Drive, Houston, Texas. Stocks of bitumastic enamels for the protection against corrosion of buried pipe lines will be available at the Houston plant.

INDUSTRIAL DEGREE DAYS
February, 1944

City	Number of Industrial Degree Days	
	55F Base	45F Base
Baltimore	493	219
Buffalo	866	576
Chicago	754	469
Cleveland	693	415
Detroit	753	480
Indianapolis	588	321
New York	646	357
Philadelphia	563	281
Pittsburgh	604	322
St. Louis	496	256

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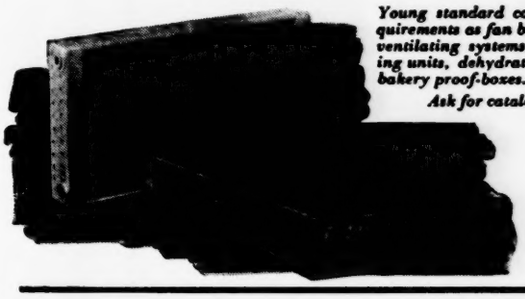

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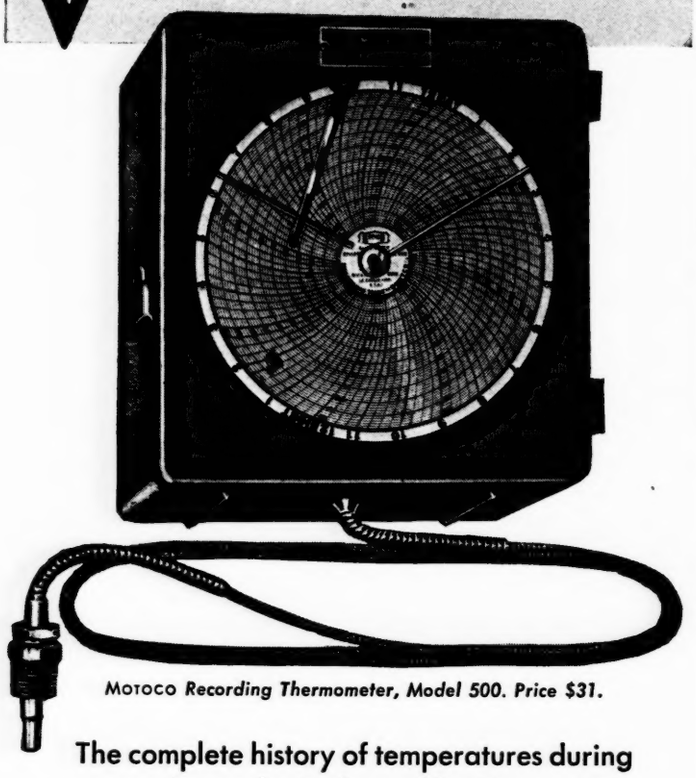

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The complete history of temperatures during processing cycles is charted by MOTOCO Recording Thermometers. Every variation in degree of heat or cold is detected and recorded at the moment of occurrence.

The easy-to-read, 6" chart has an exceptionally large range coverage. Here is a valuable aid in maintaining proper temperatures and insuring product uniformity.

Write for illustrated folder.

Illustrated here are two of the many types of MOTOCO *precision instruments made for specific industrial applications. Left: Square case pressure gauge, standard pressure ranges up to 500 pounds. Right: Indicating Thermometer, used extensively for accurate temperature indication.*

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THE ELECTRIC AUTO-LITE COMPANY

MOTO METER GAUGE AND EQUIPMENT DIVISION

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Getting Personal

Francis Oscar Jordan

After looking at the photograph, it is no surprise to learn that **Francis Oscar Jordan** (Air Processing Needs of Plywood Plane Parts, page 67) was active in football, wrestling, and track while at Purdue University. He received his mechanical engineering degree in 1918.

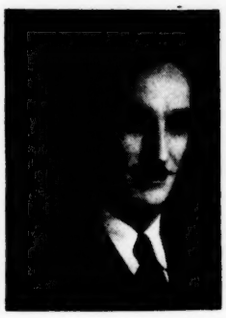
During World War I he served overseas as Lieutenant with the Engineers.

For a time he was assistant track and wrestling coach, and an instructor in power plant design at Purdue.

He was designing engineer and construction superintendent for McColl, Snyder and McLean, engineers of Detroit; chief engineer for Verner, Wilhelm and Molby, architects and engineers, Detroit; Research and application engineer, Kelvinator Corp., Detroit; assistant chief engineer, Airtemp Division, Chrysler Corp., Detroit and Dayton; engineer associated with Albert Kahn Associated Architects and Engineers, Detroit.

Mr. Jordan is technical editor, "Air Conditioning and Refrigeration News," and technical director, Industrial Institute, Chicago. He has written text books and handbooks, and he is also credited with a number of inventions.

Besides his engineering background, he owns and operates a stock and poultry farm. What is more exciting is that he is a licensed airplane pilot and operates his own plane.



Raymond Little

Raymond Little (Weather Trends Indicated by Degree-Day Study, page 63) has had a general all around experience in the gas field, following his graduation as a mechanical engineer from the University of Pittsburgh.

For the past eighteen years he has been concerned with public utility load-building activities involving the use of natural gas for industrial, commercial and residential space heating, and for process application. His present position is Commercial Manager and Utilization Engineer, Equitable Gas Company, Pittsburgh, Pa.

Mr. Little is experienced in fuel applications for power plant operation, and the distribution and application of gas fuel in steel mill operation and production.

He is a victory gardener, which means that without much encouragement, he will start describing the size of his tomatoes. Besides, he is active in Civilian Defense, and civilian war effort programs.

Mr. Little is a member of the American Gas Association, Pennsylvania Natural Gas Men's Association, Engineers Society of Western Pennsylvania, and A.S.H.V.E.

J. Partington, Jr. (Industrial Cooling as a Production Aid, page 47) graduated from Haverford College in 1930, and the same year entered the General Electric Test Course in Schenectady.

When the company formed its air conditioning department in 1932, he became a member. Since that year, he has served as field engineer, application engineer and sales engineer on the company's entire line

of air conditioning equipment, and commercial and industrial refrigeration.

One of his recent large jobs was the engineering and supervision of installation of a 1,100-ton air conditioning system in a windowless war plant erected by the Defense Plant Corporation.

Ritchie P. Dewey

Ritchie P. Dewey (Close Machine Tolerances Possible Through Temperature Control, page 60) was born in Rockford, Ill., attended local schools, and was graduated in 1915 from the University of Illinois.

He was with the Ordnance Department, U. S. Army from 1917 to 1919, and then was sales engineer with Barber Coleman Co., for 9 years. From 1928-1938, he was chief engineer, Temperature Control Division of that company. Mr. Dewey served as division manager during the last 5 years with that company.

For the next 3 years he was manager of the Aircraft Products Division, and in 1941 went with the Woodward Governor Co., as chief engineer.

Mr. Dewey developed many new designs of high production tools from 1919-1928. He was actively associated with the development of the Barcol system of temperature regulation. He developed and patented the Barcol system of control for aircraft, and he also developed and patented the Barcol Impressor, an instrument for testing the hardness of soft metals such as aluminum.

John J. Woolfenden

John J. Woolfenden (The Case of the Waterlogged Coil, page 71) has a well rounded engineering background, although when he entered the University of Michigan, he did have a leaning towards medicine. He received degrees of B.S.E.E., and M.S. from U. of M.

He has been with Smith, Hinchman Grylls, Inc., engineers, for 17 years as chief mechanical and electrical engineer, specification writer, and chief field superintendent of electrical and mechanical construction.

Mr. Woolfenden was in charge of design and specification work for E. R. Little Co., engineers; acting chief engineer, Engineering Department, Detroit Testing Laboratory; Professor of Electrical Engineering, Lawrence Institute of Technology.

ARMY – NAVY

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